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l'environnement

PISCES IV SUBMERSIBLE DIVES, 1973 - 1982

Regional Programme Report : 83 - 20

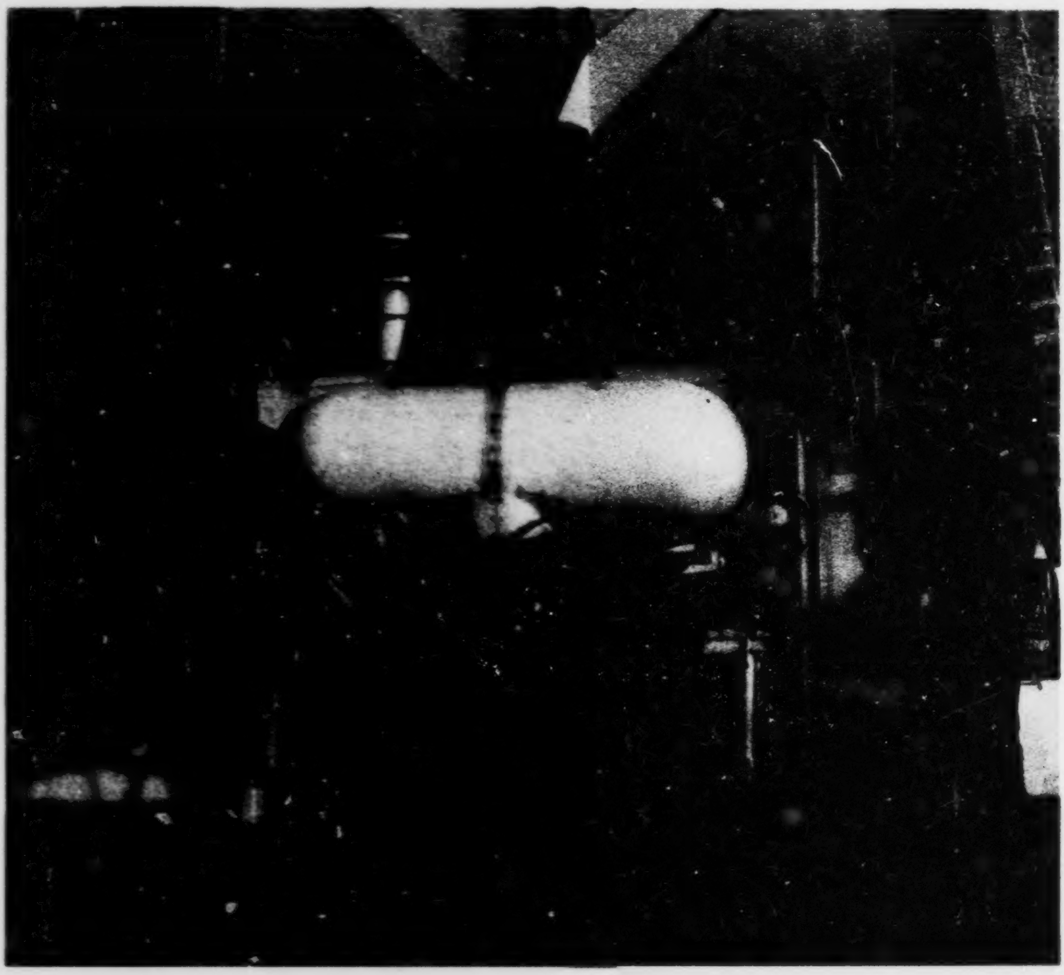
Department of Environment
Environmental Protection Service
Pacific Region

PISCES IV Submersible Dives 1973 - 1982

Regional Programme Report: 83-20

Compiled by
L. Petrie and N. Holman

1983



Abstract

The Environmental Protection Service has employed the PISCES IV three-man submersible since 1973 to visually determine the condition of the benthic habitat in the coastal water of British Columbia affected by some of the major industry sectors (ie. Pulp mills, municipal discharge areas, mine and quarrie sites, and ocean dumpsites).

This report catalogues all the existing information obtained on 128 dives (ie. observations, photographs, film clips, etc.) up to 1982.

Résumé

Depuis 1973, le Service de la protection de l'environnement emploit le submersible PISCES IV pour l'inspection visuelle de fond benthique des eaux littorales de Colombie Britannique, qui est affecté par quelques-uns des secteurs industriels les plus importants (ie. usines de pâte à papier, sites de décharges municipales, sites de mines et de carrières, et zones de déversement).

Tous les renseignments existants obtenus lors de 128 plongées (ie. les observations, les photos, les films, etc.) effectuées jusqu'en 1982 sont inclus dans ce rapport.

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1. Introduction

The coastal waters of British Columbia receive effluents from several industrial sectors, the largest contributors being pulpmills, mines, and municipal sewage plants. Certain locations along the coast have been designated as ocean dumpsites under the Ocean Dumping Control Act, and receive materials such as dredge spoil, woodwastes, etc.

The PISCES IV three man submersible has been employed by the Environmental Protection Service since 1973 to visually inspect the benthic impact in affected areas. In most cases the PISCES provides a more complete picture of the nature of benthic impact which cannot be obtained by surface deployed samplers alone (Pomeroy 1982). In various pulpmill survey dives it has been shown that "the surface of the deposits are so unconsolidated that they are not effectively sampled by grabs, etc." (Pomeroy 1982:2)

During most of the PISCES survey dives observations as well as photographs and 16 mm films have been taken and will be documented in this report as they apply to each industry sector under study. The PISCES is capable of specific sampling; ie. obtaining small core samples of the benthos and collecting hard objects such as rocks, shells, and clams for closer observation; as well as performing depth checks of fine benthic sediments. To date, however, such sampling procedures have only been employed in pulpmill related studies to determine the components of the deposit surfaces and will therefore not be presented in this report.

The PISCES IV is a qualitative assessment tool which has been found to be a valuable supplement to quantitative sampling methods. Often observations of relative abundances of various species noted with the PISCES IV correspond closely to otter trawl data. With the PISCES IV the zone of impact associated with various industrial activities can be determined with a minimal amount of time and effort.

2. Methods

The PISCES IV, a three man submersible operated by the Department of Fisheries and Oceans, was used to visually assess the physical condition of the benthos in areas of industrial activity on the B.C. coast. Where possible, written records of substrate type, degree of impact, and relative abundances of macrofauna were made. On all dives, photographs were taken with a Bolex 16 mm movie camera (Tungsten Ektachrome EP 7242, ASA 125 film) and a Hasselblad 70 mm still camera (Kodak Aerocolour Negative 2445 film). Reference film files were prepared following each survey to provide ready access for future reference.[1]

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[1] For available films please contact

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3.1 MUNICIPAL DISCHARGE

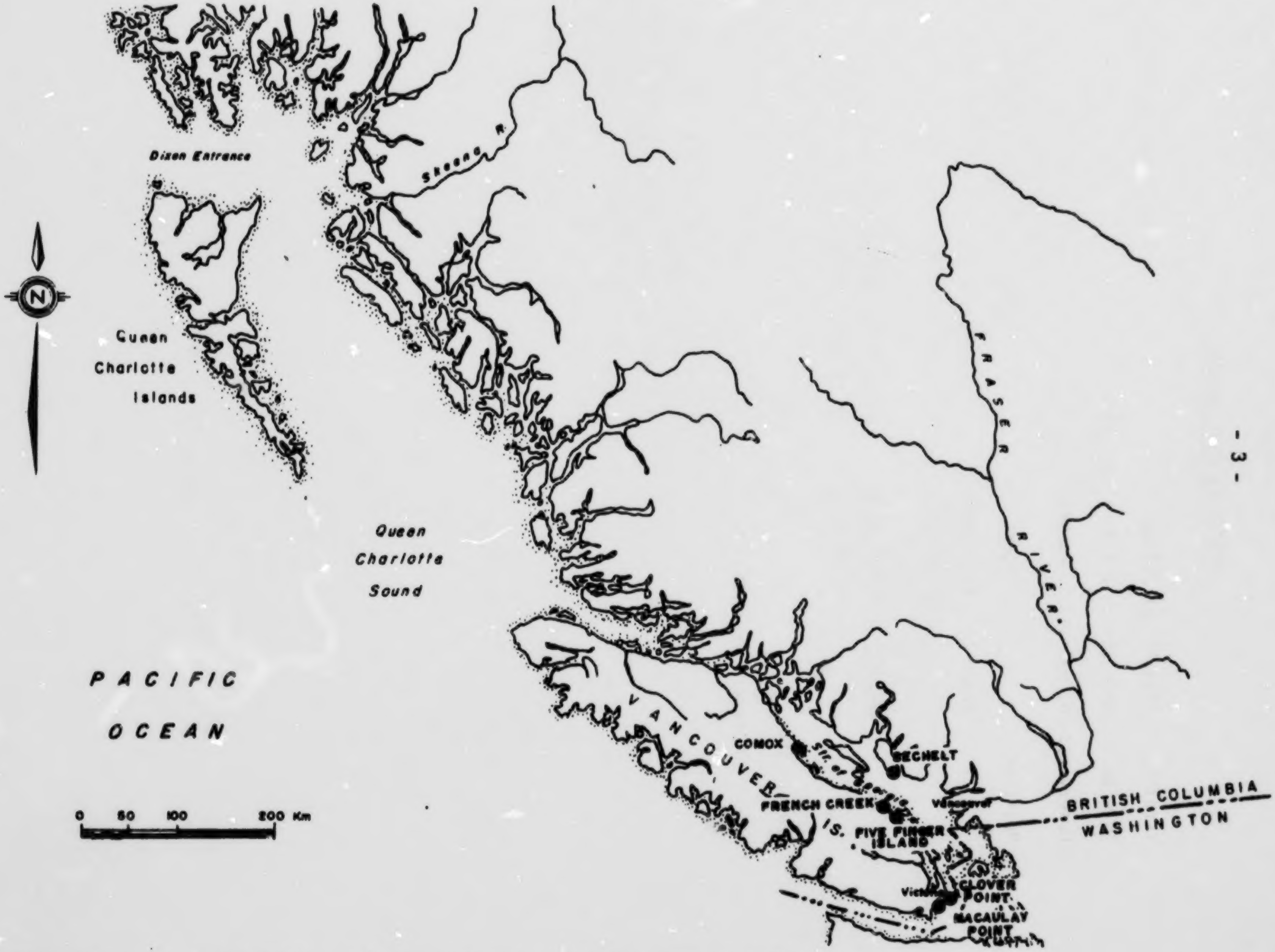
Dixon Entrance
Skeena R.
Queen Charlotte Islands
Queen Charlotte Sound
PACIFIC OCEAN
FRASER RIVER
VANCOUVER IS.
Str. of Georgia
COMOX
SECHELT
FRENCH CREEK
FIVE FINGER ISLAND
Vancouver
Victoria
CLOVER POINT
MACAULAY POINT
BRITISH COLUMBIA
WASHINGTON
N
0
50
100
200 Km

FIGURE I LOCATION OF MUNICIPAL DISCHARGE SITES

PISCES IV DIVE RECORD

Location: Five Finger Island Date: January 1976

Dive No.: 382 (track 1 & 2) (Fig. 2)

Observers: N. Holman, G. Packman

Position:		Start	Turn		Finish
	track 1	49°13.60'N 124°56.30'W	49°14.08'N 124°56.72'W		49°14.25'N 124°56.04'W
	track 2	49°14.70'N 123°56.30'W	49°14.18'N 123°56.46'W	49°14.2'N 123°56.2'W	49°14.23'N 123°55.48'W

Depth: 160m

Note : No report available.

PISCES IV DIVE RECORD

Location: Five Finger Island

Date: January 1976

Dive No.: 382 (track3) (Fig. 2)

Observer: V. Bradshaw

Position:

	Start	Finish
	$49^{o}14.2$ 'N	$49^{o}14.05$'N
	$123^{o}55.48$'W	$123^{o}55.03$'W

Depth: 160m

Note: No report available.

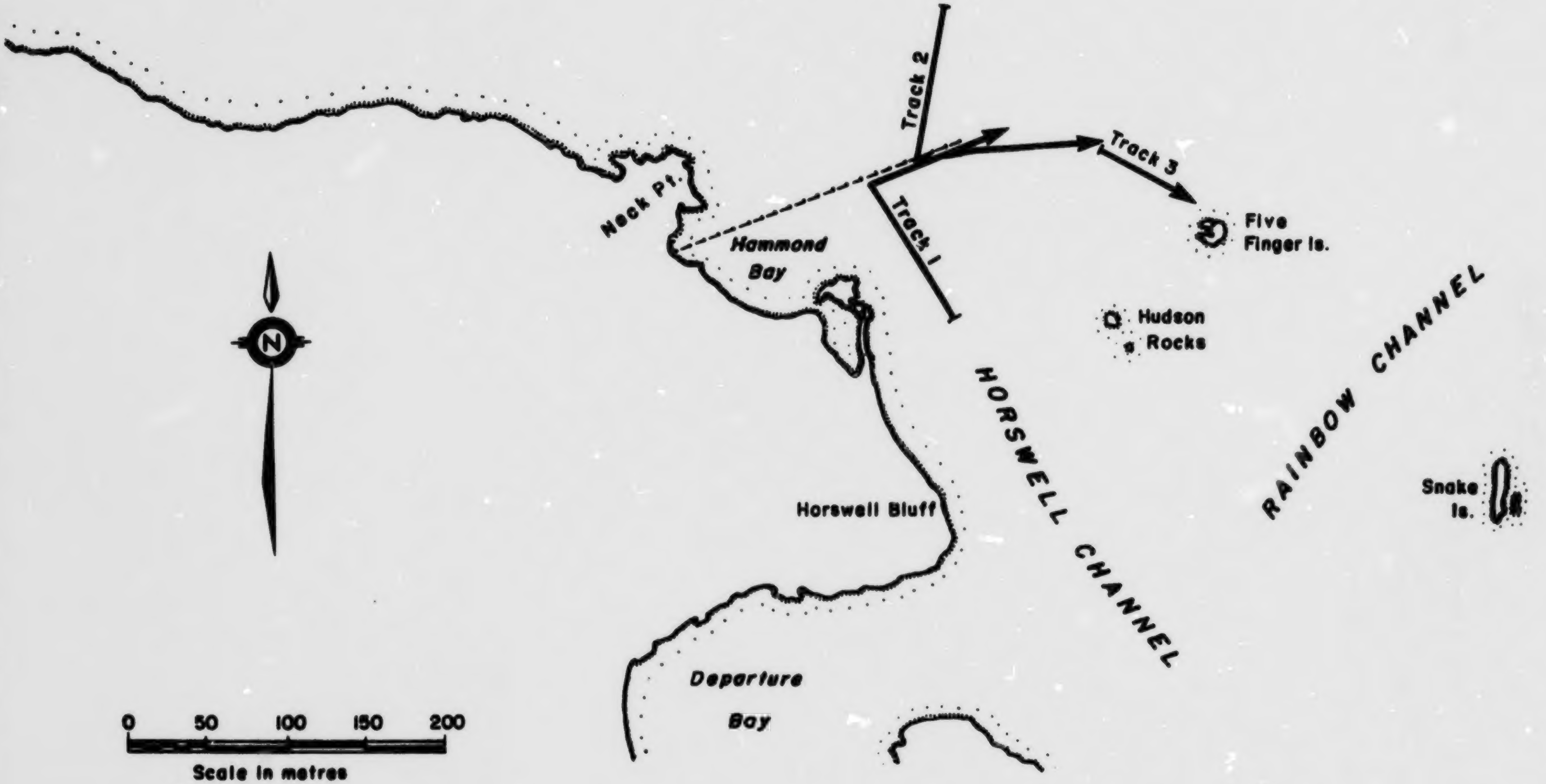
Track 2
Track 3
Track 1
Neck Pt.
Hammond Bay
Five Finger Is.
Hudson Rocks
RAINBOW CHANNEL
HORSWELL CHANNEL
Horswell Bluff
Snake Is.
Departure Bay
N
0
50
100
150
200
Scale in metres

FIG. 2 PISCES DIVE TRACKS, FIVE FINGER ISLAND SEWAGE OUTFALL (1976).

PISCES IV DIVE RECORD

Location: Cape Lazo   Date: 31 August 1976

Dive No.: 472 (Fig.3)

Observer: V. Bradshaw

Position:

	Start	Finish
	49°43.05'N	49°43.25'N
	124°48.0 'W	124°46.8 'W

Depth: 220m

Note: No report available.

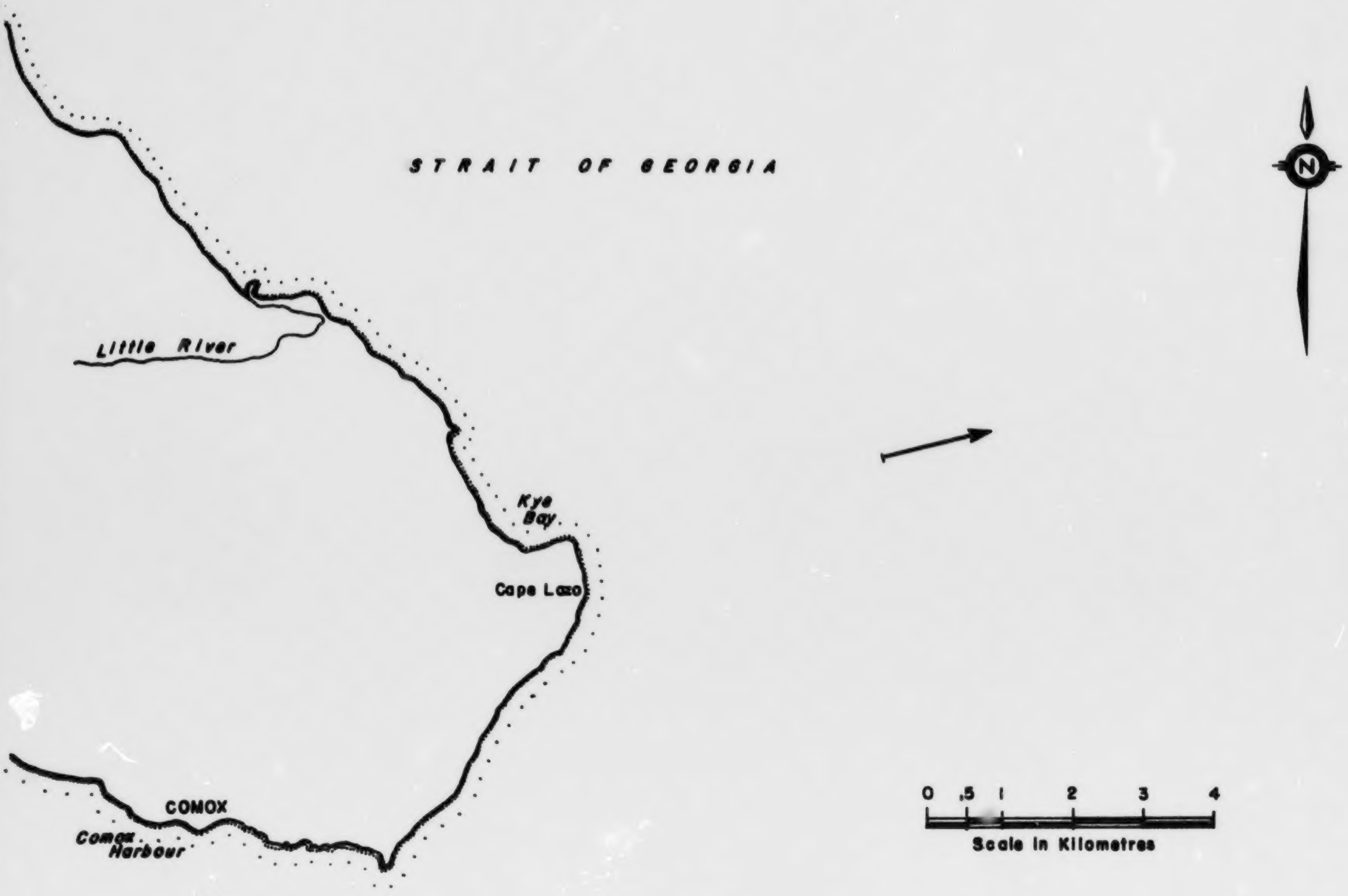
STRAIT OF GEORGIA
N
Little River
Kye Bay
Cape Lazo
COMOX
Comox Harbour
0 ,5 1 2 3 4
Scale in Kilometres

FIG. 3 PISCES DIVE TRACK OFF CAPE LAZO (1976).

PISCES IV DIVE RECORD

Location: Strait of Georgia
(off Five Finger Island)

Date: 1 September 1976

Dive No.: 474 (Track 5) (Fig. 4)

Observer: V. Bradshaw

Position:

	Start	Turn	Finish
	$49^{\circ}14.24'$N	$49^{\circ}14.31'$N	$49^{\circ}14.52'$N
	$123^{\circ}53.68'$W	$123^{\circ}53.40'$W	$123^{\circ}53.53'$W

Depth: 250m

Visibility: 6 - 10m

Bottom Characteristics: hard packed clay, a rock face dropping 20m was discovered.

Current: approximately 0.9 km/hr - 1.0 km/hr

Benthic Fauna

The benthic fauna may be divided into 2 discrete groups associated to the differing bottom characteristics (i.e., mud bottom and rock face).

Mud Bottom

On the mud bottom were observed calcareous sponges (Aphrocallistes, sp. and Rhabdocallistes sp.), burrowing sea anemones (Pachycerianthus sp.), brittle starfish (Ophuira sp., Ophiopholus sp.) in concentrations of approximately 20 per square meter, starfish (Pseudarchaster parelii alascensis), bathypelagic shrimp (Pasiphea pacifica), prawns (Pandalus platyceros), pink shrimp (P. borealis), a number of Cyclopteridae and a couple of Pacific ocean perch (Sebastes alutus).

Rock Face

The rock face was characterized by reddish branching sponges, bryozoans, cup corals and scattered squat lobsters (Munida quadraspina).

Summary

On the whole this area may be described as typical of the Strait of Georgia with observations concurrent with those of previous PISCES work and drawling and benthic grab activities.

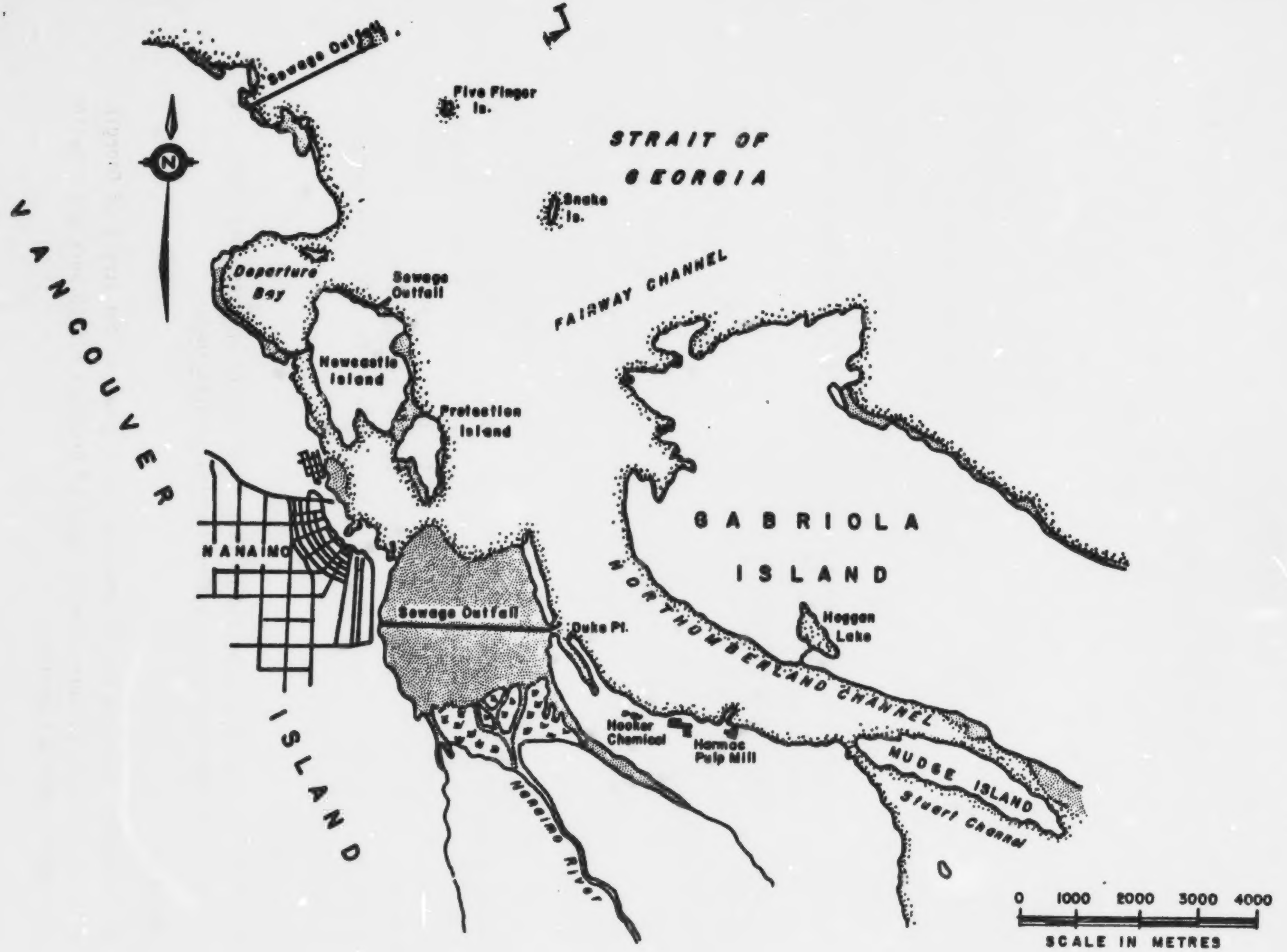
Sewage Outfall
Five Finger Is.
STRAIT OF GEORGIA
Snake Is.
N
VANCOUVER ISLAND
Departure Bay
Sewage Outfall
FAIRWAY CHANNEL
Newcastle Island
Protection Island
NANAIMO
Sewage Outfall
Duke Pt.
GABRIOLA ISLAND
NORTHUMBERLAND CHANNEL
Hoggan Lake
Hooker Chemical
Harmac Pulp Mill
Nanaimo River
MUDGE ISLAND
Stuart Channel
0
1000
2000
3000
4000
SCALE IN METRES

FIG. 4 PISCES DIVE TRACK, STRAIT OF GEORGIA (OFF FIVE FINGER ISLAND) 1976.

PISCES IV DIVE RECORD

Location: Five Finger Island Date: 13 April 1978

Dive No.: 648 (Fig. 5)

Observers: G. Packman, N. Holman

Position:	Start	Turn	Turn	Finish
	49°14.24'N	49°14.17'N	49°14.23'N	49°14.38'N
	123°56.69'W	123°56.63'W	123°56.25'W	123°56.05'W

Depth: 142m

Watercolumn

Both descending and ascending through the watercolumn revealed very little phytoplankton or zooplankton above 80m. The photic zone was observed to extend at least as far down as 80m. The number of euphausids increased markedly below the photic zone and continued to increase, being joined by copepods, amphipods, and chaetagnaths as the bottom was approached. In the vicinity of the bottom, dense concentrations of bathypelagic amphipods were apparent. While sitting on the bottom, thousands of amphipods congregated in the light pool from Pisces's main lights.

Throughout the water column there was no evidence of turbidity at all. Light from the surface was observed to extend to the bottom at the diffuser. There was no visually apparent increase in turbidity of plankton concentration during the ascent from the diffuser as compared with the initial descent.

CTD Data

	Temperature	Conductivity	Dissolved Oxygen
Surface	13.00°C	31.18m mhos/cm	8.86 mg/l
Bottom (on descent)	8.07°C	33.50m mhos/cm	8.97 mg/l
Bottom (at diffuser)	9.70°C	32.30m mhos/cm	8.03 mg/l

Bottom Characteristics

At the position of initial descent to the bottom it was observed to be gravelly and rocky with a covering of detritus. The depth at this point was 142m. These characteristics are felt to be typical of the entire area of discharge pipe and persisted throughout the dive. A cliff was, however, discovered while proceeding from the drop location to the outfall pipe. The cliff was approximately 7 - 10m in height and composed of rock. The depth at the top of the cliff was 112m with the substrate being very rocky and having no overlying sediment layer.

The substrate in the immediate vicinity of the sewage diffuser varied between sand and gravel. There was no apparent accumulation of organic material opposite the ports.

Biological Observations

Upon initial arrival at the bottom, a dogfish (Squalus canthisa), a number of ratfish (Hydrologus colliei) and a starfish (Henricia sp.), were observed. Also observed along the flat bottom were living and dead sponges (Aphrocallistes sp.), squat lobsters (Munida quadrispina), prawns (Pandulus platyceros), shrimp (Pandalus sp.), hermit crabs (Pagurus sp.), Brachiopoda, and sculpins (Cottidae).

After running along the bottom for a short period of time a rocky cliff was encountered. Fauna inhabiting this rocky area included a large number of siliceous sponges (Aphrocallistes sp. and Chonelasma calyx), sea anemones (Metridium senile and Stomphia sp.), an unidentified starfish (Asteroidae), calcareous tubiculous polychaetes and a decorator crab (Oregonia gracilis).

After ascending the cliff the bottom composition changed again to what it had been at the commencement of the dive. Shortly thereafter the pipe was located. A variety of fauna was observed in the vicinity of the pipe. These forms included sea anemones (Stomphia sp.), starfish (Ceramaster patagonicus), skillfish (Erilepis zonifer), and lemon sole (Parophrys vetulus).

The number of fish increased as the diffuser was approached with lingcod, rockfish and pricklebacks being the dominant types. At any given time, up to ten or more lingcod were visible at the outer edge of the pool of light from the PISCES IV.

The Effluent Diffuser

The effluent diffuser is constructed in a Y share. Dams were apparent on each arm and on an extension of the main pipe. These would require a diver to open and close them. A large concrete block was observed directly out from the end of the main diffuser pipe and this was assumed to have been the base from which the pipe was pulled out from shore. It was noted that there was no effluent being discharged from the last eleven ports on each arm.

Diffuser Impact

The most notable observation made in connection with the diffuser was the apparent lack of accumulation of organic material on the bottom adjacent to the ports. There was also very little in the way of non-degradable material around the ports. Some non-degradable material had collected around the end of the centre pipe. This had presumably been deposited before primary treatment had begun.

The effluent was observed to be a grey suspension which rose straight up from ports, diffusing rapidly to the point where it could no longer be seen. In a number of cases sea anemones were observed attached on the upper side of the ports just out of the effluent stream. Fish (lingcod, rockfish and pricklebacks) were also observed in great numbers around the diffuser, staying just out of the effluent stream.

The fauna in the vicinity of the diffuser appeared healthy and was the most abundant that we have ever seen from Pisces IV in terms of fish. It would be advisable, however, to monitor these fish for heavy metal and PCB contamination which may stem from the discharge. This may best be accomplished by means of hand-lining for fish and prawn trapping for invertebrates.

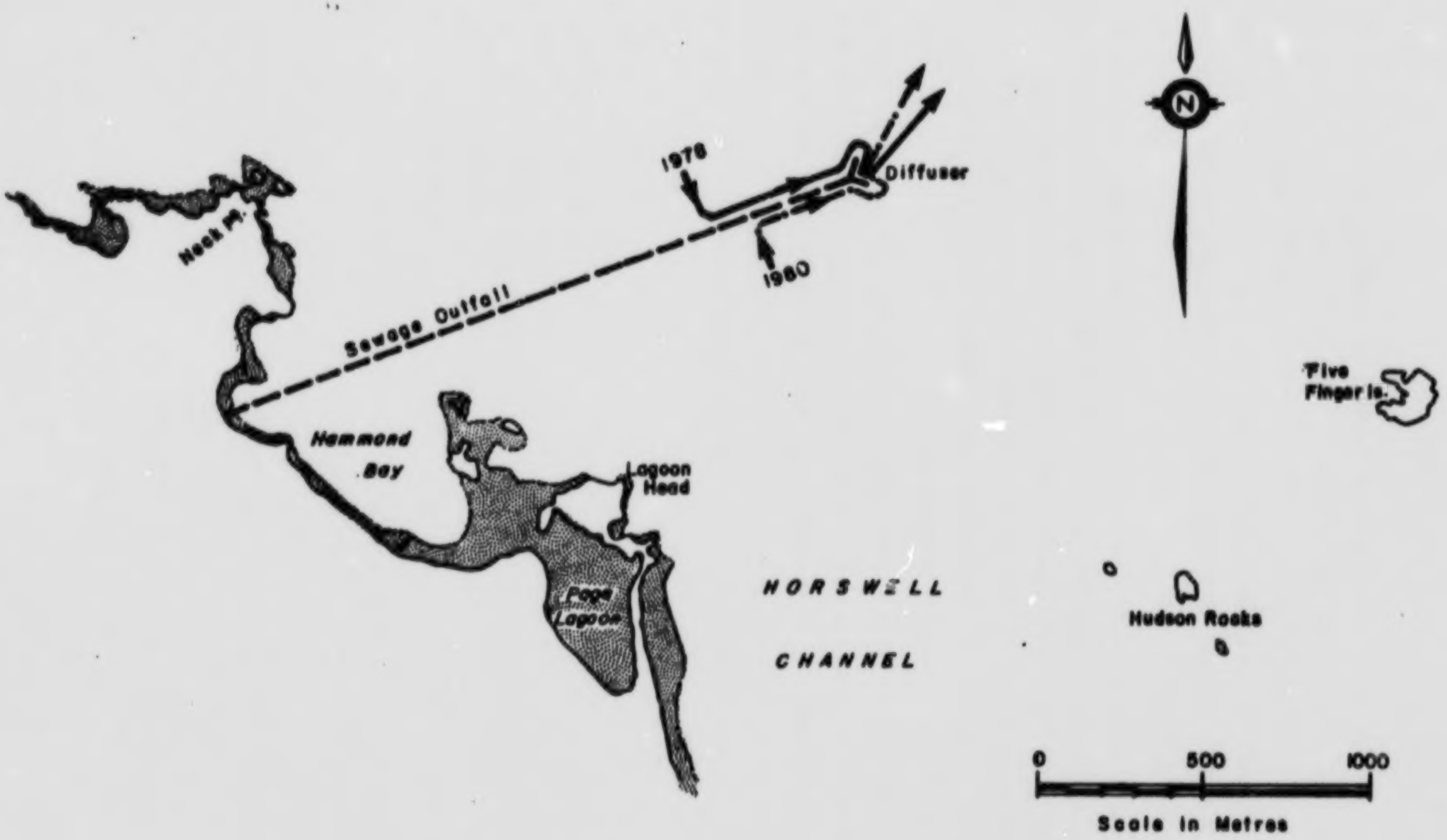
Neck Pt.
Sewage Outfall
1978
1980
Diffuser
N
Hammond Bay
Lagoon Head
Page Lagoon
HORSWELL
CHANNEL
Hudson Rocks
Five Finger Is.
0
500
1000
Scale in Metres

FIG. 5 PISCES IV DIVE TRACKS, FIVE FINGER ISLAND OUTFALL (1978 and 1980)

PISCES IV DIVE RECORD

Location: French Creek **Date:** 16 April 1978

Dive No.: 652 (Fig. 6)

Observers: G. Packman, N. Holman, D. Brothers

Position:

	Start	Finish
	49°21.2'N	49°22.0'N
	124°20.2'W	124°21.2'W

Depth: 55m

Watercolumn

The watercolumn was fairly clear throughout with little or no phytoplankton, zooplankton or detritus present. The only notable zooplankton group present was pelagic amphipods. The visibility on the bottom at 55m was approximately 12 metres.

Bottom Characteristics

The bottom was firm being composed of sand and mud. As the pipe was approached some gravelly patches were observed as well as some hummocks near the French Creek marina breakwater. The bottom at the diffuser end was sandy and firm.

Bottom Fauna

The most notable feature of the bottom fauna was the uniform distribution of small sea whips.

The remaining fauna was also evenly distributed and included those outlined in the following table.

PHYLUM	TAXON	COMMON NAME	RELATIVE ABUNDANCE (1-10)
Cnidaria	*Ptilosarcus gurneyi*	Sea pen	1
		Sea whip	10
	Pachycerianthus fimbriatus	Burrowing sea anemone	Beginning of Dive - 1 Just before pipe located 10(1-2/m^2)
Mollusca	*Archidoris ohdneri*	Nudibranch	1
	Dirona albolineata		2
	Gastropod eggs		1 sighting
	Octopus sp.		2 sighted (large)
Polychaeta	Sabellidae		9
	Unidentified burrowing tubiculous polychaetes		10
	Calcareous tubiculous polychaetes		8
Arthropoda	*Pagurus* sp	Hermit crab	7
	Lopholithodes sp.	Box crab	2 (just after pipe found
	Oregonia gracilis	Decorator crab	2
Echinodermata	*Luidia foliolata*		1
	Pisaster brevispinus		1
	Solaster endeca		2
	Pycnopodia helianthoides		1
	Orthasterias koehleri		2
	Unidentified Asteroidea		2
	Parastichopus californicus		1
Pisces	Zoarcidae	Eelpouts	6
	Sebastes sp	Rockcod	3
	Ophiodon elongatus	Lingcod	2
	Agonidae	Poacher	3
	Pleuronectidae	Sole	4
	Stichaeidae	Prickleback	3
	Cottidae	Sculpin	1
	Porichthys notatus	Plainfin Midshipman	2
	Erilepis zonifer (?)	Skilfish (?)	1 possible sighting

Diffuser Description

The effluent pipe appeared to be approximately 40cm - 60cm in diameter and was suspended approximately 30cm above the bottom by the concrete stabilizing blocks. The diffuser was fabricated of stainless steel with the ports located on the northern side and a cover on the open end. Only a trickle of fresh water was coming out at the time.

Conclusions

At the time of the dive there appeared to be little or no effect on the bottom fauna stemming from the diffuser, however full operation had not as yet commenced. Small patches of organic material were apparent adjacent to the diffuser ports but these were not felt to be problematic as yet. Although no effects were observed on this dive the dive was a useful "before operation" view of the site and should be repeated in approximately two years to see what changes have occurred.

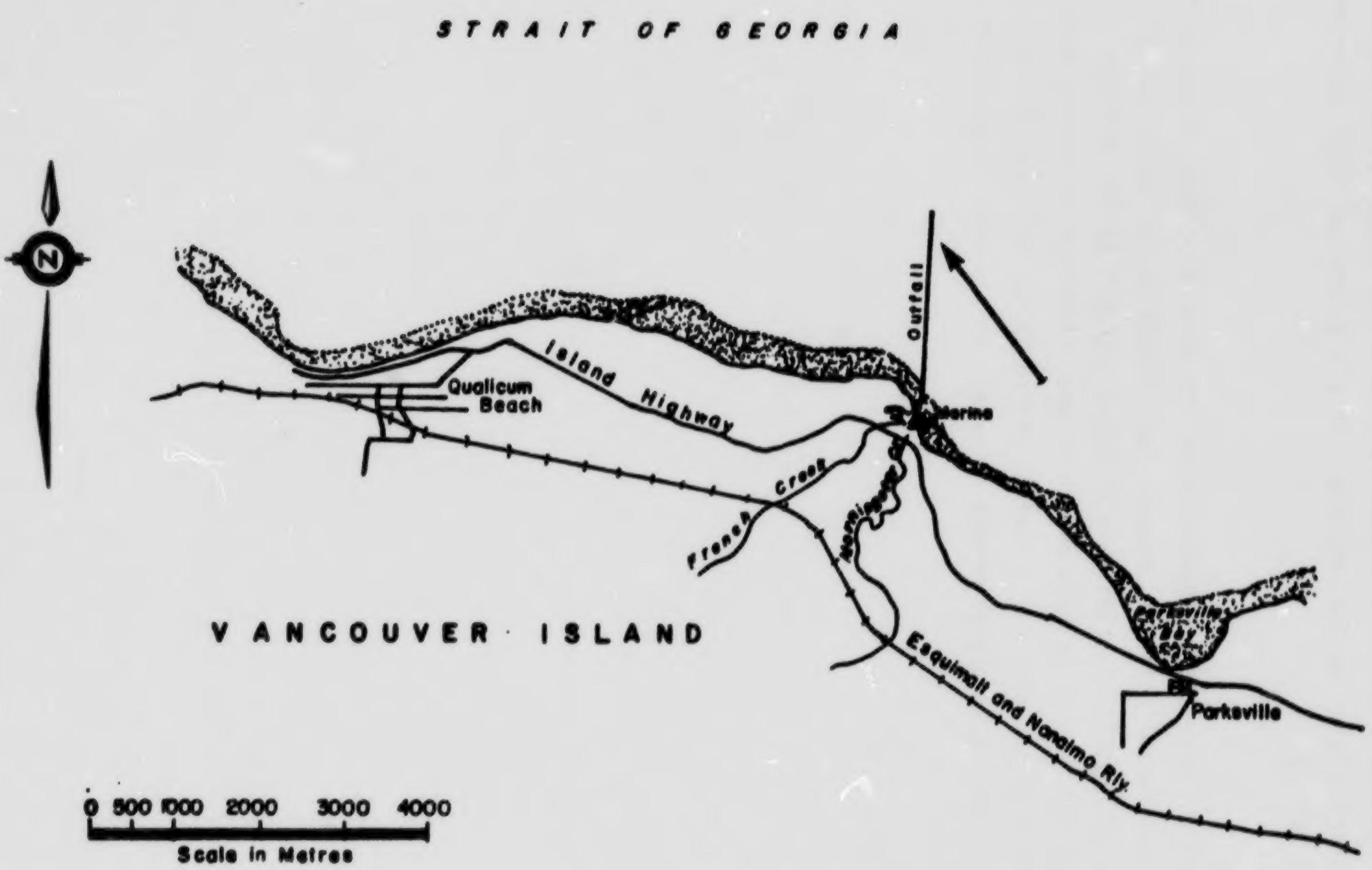
STRAIT OF GEORGIA
N
Outfall
Marina
Qualicum Beach
Island Highway
French Creek
Morningstar Cr.
Parksville Bay
Parksville
Esquimalt and Nanaimo Rly.
VANCOUVER ISLAND
0 500 1000 2000 3000 4000
Scale in Metres

FIG. 6 PISCES DIVE TRACK, FRENCH CREEK SEWAGE OUTFALL (1978).

PISCES IV DIVE RECORD

Location: Comox, Cape Lazo

Date: 1 December 1978

Dive No.: 719 (track 1) (Fig. 7)

Observers: G. Packman, N. Holman

Position:	Start	Turn	Finish
	49°42.12'N	49°42.47'N	49°42.53'N
	124°48.87'W	124°49.12'W	124°50.27'W

Depth: 63m

Water Column

The water column was very clear, with good visibility throughout most of the descent. Some detritus and zooplankton were encountered between 40 metres and the bottom (63 metres). The readings observed on the CTD unit are presented in Table 1.

TABLE 1 CTD READINGS

Depth	Temperature(°C)	Conductivity	Dissolved Oxygen (mg/l)
0m	8.50	31.34	9.40
15m	8.55	31.36	7.40
27m	8.57	33.40	8.70
45m	8.80	32.00	7.85
63m (bottom)	9.00	32.50	6.40
53m (bottom)	8.85	32.19	7.30
43m (bottom)	8.80	32.14	7.00
20m (bottom)	8.50	31.36	8.00
16m (bottom)	8.50	31.36	7.50

Bottom Characteristics

Throughout the course of the dive the substrate was sandy in nature, with the grain size being smaller in the deeper portion of the dive. The substrate looked excellent for construction purposes with the slope not being a problem for a pipeline. The substrate was coarse enough that divers would not have a visibility problem arising from stirred up sediment. At the 20 metre depth rippling was apparent in the sandy substrate, presumably arising from wave surge.

Holes in the bottom arising from infaunal burrowers were not abundant at any time during the dive. Worm castings were noted on the surface of the sediment in the deeper portion of the dive.

Bottom Fauna

A summary of the benthic and bathypelagic epifauna noted during this dive is presented in Table 2. The fauna observed was typical of a sandy bottom community and changed with depth as the shore was approached. In the deeper area covered at the beginning of the dive the dominant faunal forms included small unidentified shrimp, thin white sea pens and Dover or lemon sole. Throughout the dive a diverse representation of starfish was noted. A band of different faunal forms was encountered between 30 and 25 metres of depth. In this area there occurred an abundance of burrowing anemones (Pachycerianthus sp.) scallops and small octopii. The dominant fish type throughout the dive was sole.

TABLE 2

TAXON		ABUNDANCE
Sponge	- unidentified	1 noted
Polychaeta	- Serpulida and/or Sabellide	Evenly spaced and fairly abundant below 40 metres
Anthozoa	- *Ptilosarcus gurneyi*	Approximately 3 noted
	- unidentified thin white sea pen	Approximately 29 noted in deeper portion of dive site
Actinaria	- *Metridium senile*	3 noted
	- *Pachycerianthus* sp.	Noted occasionally in deeper water. Between 30-25 metres there were 3-4 per square metre
	- unidentified Anemone	Noted occasionally
Gastropoda	- Nudibranchia (unidentified)	Occasionally noted
	- *Dirona* sp.	Occasionally noted
	- *Armina* sp.	Occasionally noted
	- *Gastropteron pacificum*	1 noted
Bilvalvia	- unidentified scallop	Abundant - approximately one per square metre at the 28 met depth
Cephalopoda	- *Octopus* sp.	Fairly common at 25 metres
	- unidentified Squid	Noted occasionally
Crustacea	- *Pandalus platyceros*	1 noted
	- unidentified pink shrimp	Noted occasionally
	unidentified small pink shrimp	Lots at beginning of dive - approximately 5 per square metre. Numbers declined as depth decreased.
	- *Pagurus* sp.	Noted occasionally
	- *Pugettia producta*	2 noted
Asteroidea	- *Solaster* sp.	Noted occasionally
	- *Mediaster* sp.	Noted occasionally
	- *Pycnopodia* sp.	Noted occasionally
	- *Evasterias* sp.	Fairly common

TABLE 2 (continued)

TAXON		ABUNDANCE
Asteroidea (continued)	- *Luidia* sp.	Noted occasionally
	- *Pteraster* sp.	Noted occasionally
	- *Pisaster brevispinus*	Fairly common
	- *Dermasterias imbricata*	Noted occasionally
	- *Orthasterias koehleri*	Noted occasionally
	- Unknown Asteroidea	Noted occasionally
Echinoidea	- *Strongylocentrotus droebachiensis*	1 noted
Ascidiacea	- *Ascidia paratropa*	Fairly common around the 28 metre depth
Pisces	- Skate	3 noted
	- Clupeidae	1 noted
	- Embiotocidae (surf perch)	A school followed the boat around
	- Stichaeidae	Noted occasionally
	- *Ophiodon elongatus*	3 noted
	- Cottidae	Noted occasionally
	- *Scorpaenichthys marmoratus*	1 noted
	- Agonidae	Noted occasionally
	- Sole (Lemon or Dover)	Fairly abundant
	- *Psettichthys melanostictus* *(Sand Sole)*	Noted occasionally

Conclusions

The bottom throughout this dive was composed of compacted sand. As a result, the epifauna, although being quite diverse, was not particularly abundant. The dominant fish type was sole. The bottom slope and material appeared to be ideal for the construction of a deep marine outfall.

PISCES IV DIVE RECORD

Location:	Comox	Date: 1 December 1978
Dive No.:	719 (track 2) (fig. 7)	
Observers:	G. Packman, N. Holman	

Position:	Start	Turn	Turn	Finish
	$49^{0}40.45'N$	$49^{0}40.17'N$	$49^{0}40.58'N$	$49^{0}41.00'N$
	$124^{0}50.53'W$	$124^{0}50.43'W$	$124^{0}50.23'W$	$124^{0}50.37'W$

Depth: 78m

Water Column

Visibility was good throughout the water column with not too much detritus or zooplankton being present. A fair number of scyphozoans were observed in the upper reaches of the water column. Scyphozoans were also observed at greater depths but their numbers were decreased. Some siphonophores were noted at approximately 60 metres. The data obtained with the CTD probes are presented in Table 1.

TABLE 1 CTD READINGS

Depth	Temperature(^{0}C)	Conductivity	Dissolved Oxygen (mg/l)
40m	8.90	32.00	8.8
60m	9.20	32.50	7.3
78m (bottom)	9.30	32.90	6.4
70m (bottom)	9.18	32.50	6.5
43m (bottom)	9.12	32.39	6.6
23m (bottom)	9.00	33.20	7.2

Bottom Characteristics

The sediment type was markedly different from that observed on the Track 1 dive, that is, a soft clay mud substrate with a thin overlay of very light sediment. The visibility at or close to the bottom was very much reduced compared to the Track 1 dive location also, the sediment was much more readily disturbed and re-suspended by the submersible, hence further reducing visibility.

Bottom Fauna

A list of the fauna observed during the course of this track is presented in Table 2. During the first half of the dive the dominant epifaunal form was the thin white sea pen. There were also 5-10 infaunal holes per square metre and 1-2 pink shrimp per square metre.

During the second half of the dive, where the depth was shallower and the sediment coarser, the number of animals was reduced markedly. However, in this area very few sea pens and pink shrimp were apparent. There was still a stable, diverse and productive community present.

TABLE 2

TAXON		ABUNDANCE
Actinaria	- Metridium sp.	Noted occasionally
	- Pachycerianthus sp.	Fairly common
	- Unknown	Noted occasionally
	- Thin white sea pens	5-10 per square metre during deeper portion of the dive; after ascending slope the numbers dropped off markedly
Gastropoda	- Dirona sp.	Quite abundant on coarser sediment in shallower water
	- Nudibranchia	Noted occasionally
Cephalopoda	- Octopus sp. (small)	1 noted
	- squid	1 noted
Crustacea	- pink shrimp	1-2 per square metre at the beginning of dive declining to very few in shallower portion of dive.
	- Pagurus sp.	Noted occasionally - more frequently in shallower, sandy area.
Asteroidea	- Mediaster sp.	Fairly common
	- Pisaster brevispinus	Noted occasionally
	- Evasterias sp.	Noted occasionally
	- Pycnopodia sp.	Noted occasionally
	- Unidentified	Noted occasionally
Pisces	- Squalus acanthias	1 noted
	- Hydrolagus colliei	1 noted
	- Gadus macrocephalus	2 noted
	- Zoarcidae	Fairly common
	- Embiotocidae (surf perch)	2 schools noted
	- Sebastes sp.	2 noted
	- Ophiodon elongatus	1 noted
	- Cottidae	Noted occasionally

TABLE 2 (continued)

TAXON		ABUNDANCE
Pisces (continued)	- Agonidae	Common during first half of dive - predominant fish species during second half of dive
	- Pleuronectidae	Noted occasionally
	- *Psettichthys melanostrictus*	Noted occasionally

Conclusions

The bottom sediments in the deeper portion of this dive track were very fine indicating that currents were minimal. The bottom fauna, both epifauna and infauna, was quite abundant. Fauna could be adversely affected by the discharge of sewage, with specific reference to the accumulation of organic material in the sediments.

The fine sediment in this area would easily be stirred up by divers involved in submarine construction, reducing visibility and thereby increasing construction time and expense.

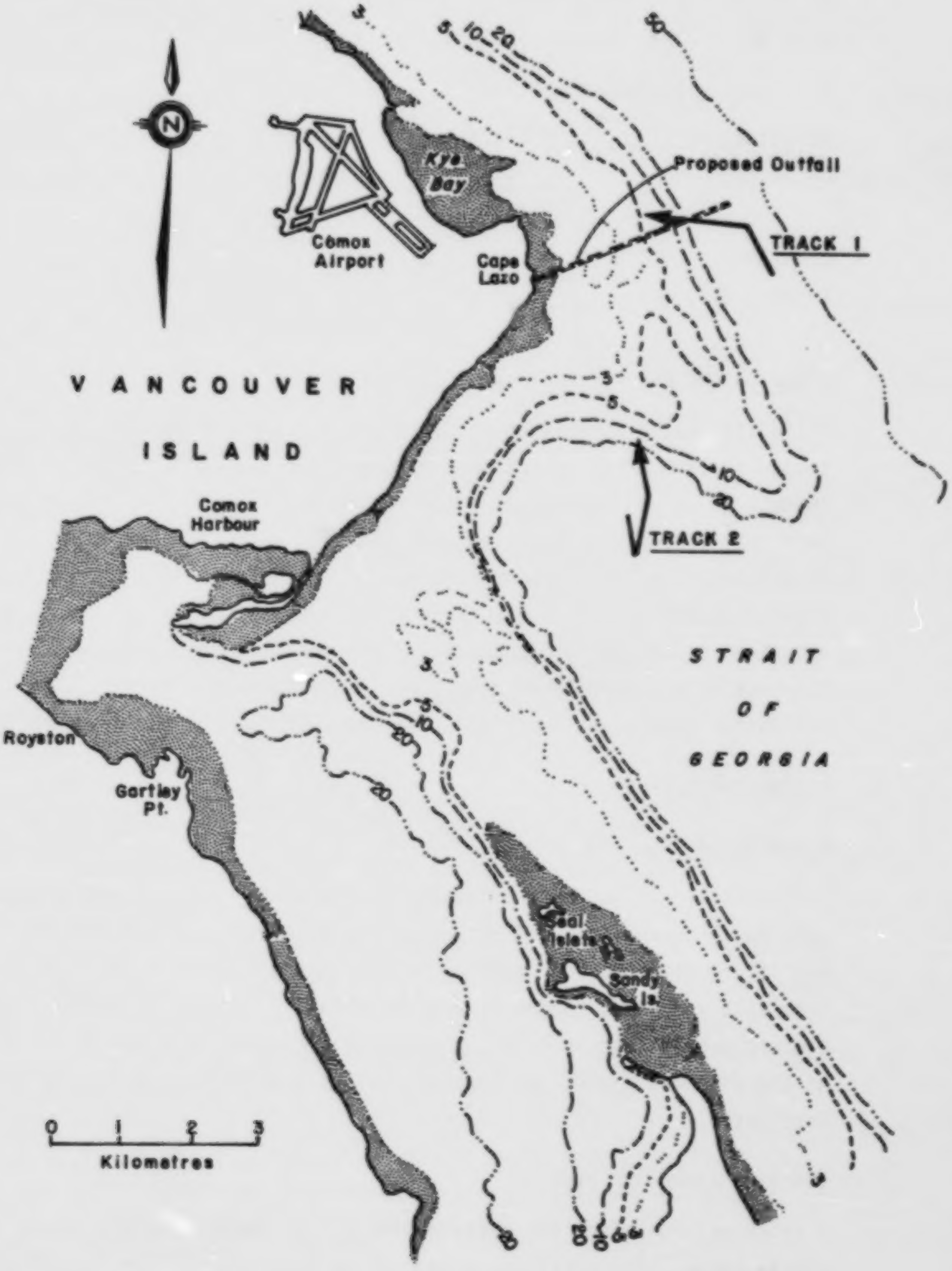
N
3
5
10
20
50
Kye Bay
Comox Airport
Cape Lazo
Proposed Outfall
TRACK 1
VANCOUVER ISLAND
3
5
10
20
TRACK 2
Comox Harbour
STRAIT OF GEORGIA
Royston
Gartley Pt.
3
5
10
20
20
Seal Islets
Sandy Is.
0 1 2 3
Kilometres

FIG. 7 PISCES DIVE TRACKS, CAPE LAZO (1978)

PISCES IV DIVE RECORD

Location: Macaulay Point Sewage Outfall Date: 7 May 1979

Dive No.: 755 (track 1) (Fig. 8)

Observers: G. Packman, B. Kay

Position:

	Start	Finish
	48°23.80'N	48°25.06'N
	123°24.68'W	123°24.35'W

Depth: 80m

Water Column Characteristics

Visibility was generally good during the descent through the water column. In the surface waters a fair bit of phytoplankton was apparent. At approximately 25 metres the amount of phytoplankton in the water column increased such that visibility decreased somewhat. At 55 metres the amount of detritus in the water increased however there was no corresponding increase in zooplankton numbers. At 55 metres detritus such as toilet paper was noted in the water column which apparently originated with the sewage discharge. A fair bit of sewage related debris was noted suspended in the water just above the bottom throughout the dive. The depth throughout the dive was 80 metres.

Bottom Characteristics

Approach to Pipe

Upon initial arrival on the bottom the substrate was observed to consist of soft mud and sand, and did not appear to have been contaminated by sewage debris. During the approach to the pipe the substrate composition varied from silt and sand, to gravel and occasionally to rock. Initially natural organic debris such as drifting detached algae was observed on the bottom. As the pipe was approached however various bits of typical sewage debris were noted.

Tracking Along The Pipe

A track was run along the eastern side of the sewage outfall to the discharge point. The substrate along the eastern side of the outfall pipe consisted of silt and shell debris which had piled up against the pipe.

This varied occasionally to a sandy substrate and a substrate composed of gravel and shells. As the end of the outfall was approached the quantity of anthropogenic debris increased. The physical appearance consisted of scouring in the immediate vicinity of the discharge point and the accumulation of a mound of black organic material beyond that. The scoured area directly opposite the discharge was gravelly in nature with some but not a great deal of sewage debris present. A great deal of plastic and other debris including a credit card and an identification card from Gorge Road hospital was present along with the organic ooze. On a course run out directly from the end of the pipe the debris was observed to thin out at approximately 20 metres from the pipe end. Approximately 40 metres from the discharge point the bottom was composed of broken scallop shells, fine organic material and bits of plastic and tin foil. Therefore it was felt that considerable impact was still being effected at that point.

The diffuser at the end of the sewage outfall was broken off approximately half way along its length. Small accumulations of debris and organics were apparent opposite the operating ports. The sewage effluent was discharging at an extremely high rate when the Pisces initially arrived at the discharge point. However while we were observing the pipe pumping was shut down and the discharge cased.

Fauna

A summary of the fauna noted on the approach to the outfall pipe is contained in Table 1. It may be seen from this table that the fauna, while being diverse was not exceptionally abundant and was mainly epifaunal.

The fauna observed during the run down the pipe is summarized in Table 2. Scallops were one of the dominant faunal forms beside the pipe, while sea anemones (Metridium sp.) were abundant on the pipe. Sea urchins (Strongylocentrotus sp.) were abundant in concentrated groupings on and beside the pipe.

At the discharge point in the direct discharge stream no benthic infauna or epifauna were present. Large numbers of rock cod (Sebastes sp.) and ratfish (Hydrolagus colliei) were observed swimming around the effluent stream. Off to the sides, away from the direct impact of the sewage discharge, hermit crabs (Pagurus sp.) were the dominant faunal form and were present in large numbers.

Conclusion

The areas away from the impact of the sewage discharge were typically compacted mud, sand and gravel with a predominantly epifaunal community. The fauna in these areas, although not particularly rich appeared to constitute a diverse, stable epifaunal community. The bottom directly opposite the broken end of the diffuser where the main discharge occured consisted of a black organic accumulation devoid of an epifaunal community. The bottom along the sides of the diffuser was composed of a black, reduced sediment. Large numbers of hermit crabs (Pagurus sp.) were present in this area which may indicate an increase in biomass but as the community diversity is very low this represents a classic pollution situation.

TABLE 1 FAUNA NOTED DURING APPROACH TO PIPE

Faunal Form	Abundance
Metridium sp.	12 noted attached to rocks and other solid substrata
Anemones - unidentified	12 noted
Calcareous Tubiculous Polychaetes	noted on ricky substrata
Scallops	noted occasionally
Fusitriton sp.	10 noted
Neptunea sp.	1 noted on a piece of wood
Octopus sp.	1 small individual noted
Nudibranch	1 noted
Pagurus sp.	approximately 10 were noted during the first five minutes of the dive after that 8 were noted during the remaining approach to the pipe
Parastichopus californicus	1 noted
Cucumaria sp.	1 noted
Strongylocentrotus sp.	1 noted
Solaster stimpsoni	5 noted
Luidia sp.	5 noted
Henricia sp.	2 noted
Ophiuroidea	noted occasionally throughout approach
Hydrolagus coliei	1 noted
Gadus macrocephalus	1 noted
Zoarcidae	1 noted
Stichaeidae	2 noted
Ophiodon elongatus	3 small individuals noted

TABLE 1 (continued)

Faunal Form	Abundance
Agonidae	3 noted
Pleuronectidae	4 noted
Ascidia peritropa	noted infrequently
Ascidians unidentified	noted infrequently

TABLE 2 FAUNA NOTED ALONG PIPE

Faunal Form	Abundance
Metridium sp.	many on pipe, along its length and at end
Unidentified anemone	1 noted
Calcareous tubiculous polychaetes	a few on pipe end
Scallops	generally 2-3/m^2 except for a bed where 20-30/m^2 were observed the numbers diminished in the immediate area of the discharge but were approximately 10/m^2 at approximately 25m from the outfall end.
Fusitriton sp.	3 noted
Lopholithodes sp.	2 noted
Pagurus sp	many around the outfall end, dominant faunal form in that area
Florometra serratissima	noted occasionally along pipe
Gorgonocephalus sp.	1 noted
Strongylocentrotus sp.	noted in piles along pipe
Solaster stimpsoni	5 noted along pipe a few noted around and on pipe end
Dermasterias imbricata	one noted
Luidia sp.	one noted
Hydrolagus colliei	a few noted around pipe end
Sebastes sp.	a school of juveniles was noted while running down the pipe. many (approx. 50) large rockfish were noted in the effluent.
Ophiodon elongatus	one noted along pipe one noted at pipe end

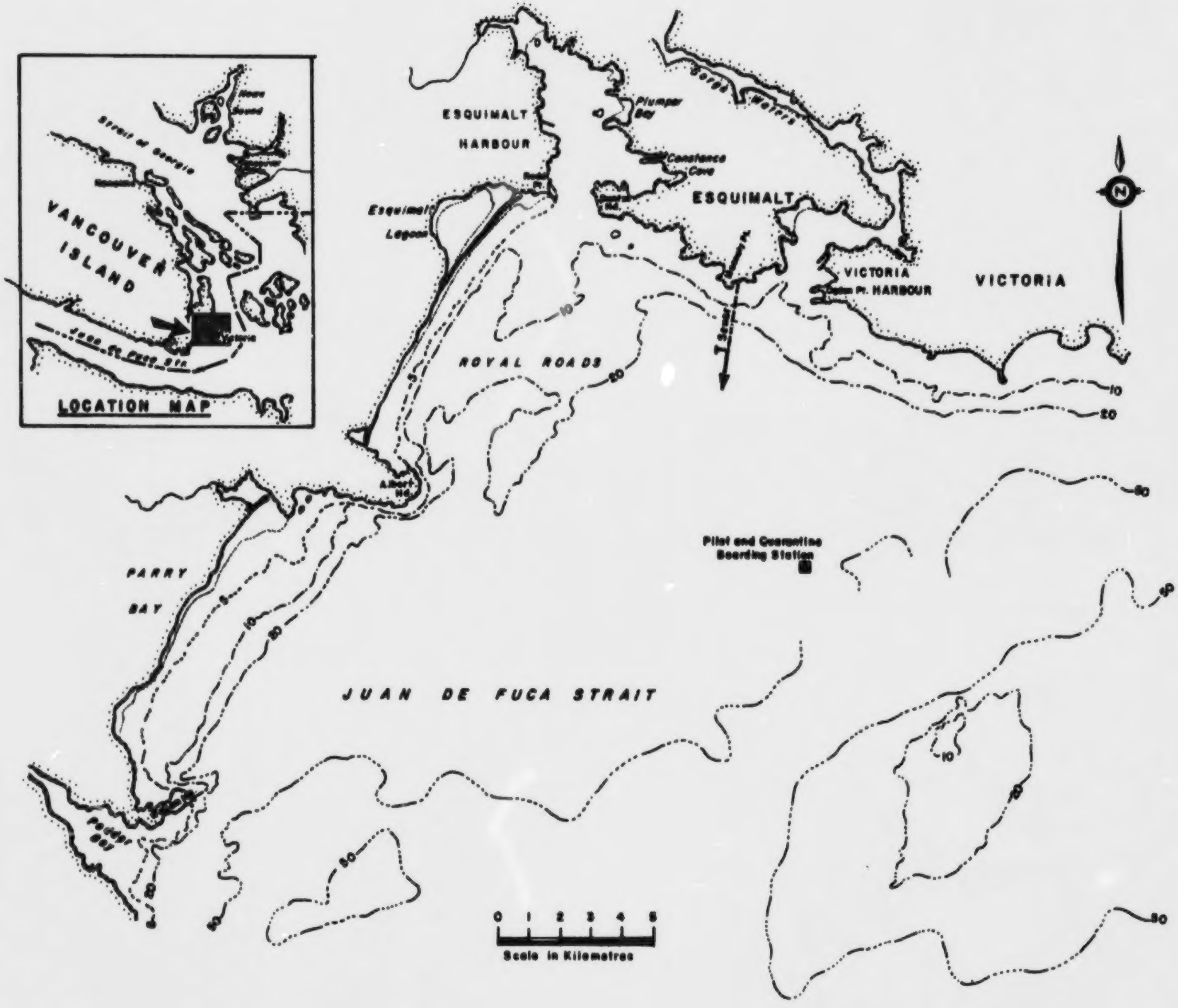
LOCATION MAP
Strait of Georgia
VANCOUVER ISLAND
Juan de Fuca Str.
Victoria
ESQUIMALT HARBOUR
Esquimalt Lagoon
Plumper Bay
Constance Cove
Gorge Waters
ESQUIMALT
VICTORIA HARBOUR
VICTORIA
ROYAL ROADS
Albert Hd.
PARRY BAY
Pedder Bay
JUAN DE FUCA STRAIT
Pilot and Quarantine Boarding Station
N
10
20
50
0 1 2 3 4 5
Scale in Kilometres

FIG. 8 PISCES DIVE TRACK, MACAULAY POINT SEWAGE OUTFALL (1979).

PISCES IV DIVE RECORD

Location:	Sechelt - Trail Bay		Date: 10 May 1979
Dive No.:	763 (track 1) (Fig. 9)		
Observers:	G. Packman, N. Holman		
Position:		Start	Finish
		49°26.72'N	49°26.58'N
		123°47.82'W	123°46.00'W

Depth: 100m

Water Column

In the surface waters large numbers of copepods were observed. These were noted to extend down through the water column to approximately 50 metres. Zooplankton and detritus were observed to extend to a depth of approximately 75 metres. Between the 100 metre depth and the bottom ctenophores, siphonophores, scyphozoans and euphausids were noted. Pelagic amphipods and shrimp (*Pasiphea pacifica*) were also noted in the waters just above the bottom.

Bottom Characteristics

The bottom throughout most of the dive was a very soft silty mud substrate indicating very little current in the area. What little current there was was flowing from the south east at the time of observation. Infaunal holes in the bottom numbered approximately 1-2/m^2. Towards the end of the dive a mud slope was encountered, which gradually steepened whereupon the bottom changed to a mixed cobble and silt substrate. At the end of the dive the bottom levelled off with the substrate returning to fine silt.

Bottom Fauna

A list of the fauna noted throughout the dive is presented in Table 1. The most common faunal form throughout the dive was the pink shrimp (*Pandalus* sp.) which averaged approximately 1/m^2. Sidestripe shrimp (*Pandalopsis dispar*) became almost as common as pink shrimp during the second half of the dive. Infaunal holes in the mud sediment averaged less than 1 per square metre. Generally speaking the bottom fauna was fairly sparse, typical of a soft mud substrate.

TABLE 1 FAUNA NOTED THROUGHOUT DIVE

Faunal Type	Abundance
Aphrocallistes sp. (Glass sponge)	- 1 specimen noted attached to a boulder
Nemertea	- 10 noted specifically, however they were noted occasionally throughout the dive.
Pachycerianthus sp. (burrowing anemones)	- 23 noted throughout dive.
Unidentified Anemone	- 2 noted during dive.
Neptunea sp.	- 2 noted on open substrate. - a large number were observed on the only log noted during the dive.
Octopus sp.	- 1 noted
Rossia pacifica	- 1 noted
Polychaeta - calcareous tubes	- noted infrequently on rocks.
- soft tubes	- numbers increased markedly during last half of dive.
Pink Shrimp	- most frequent faunal form noted. - 1-2/m^2 throughout the dive.
Pandalus platyceros (prawn)	- 4 noted on open substrate. - a number of prawns were noted around the only log observed on the dive.
Pandalopsis dispar	- noted infrequently during first half of dive but increased markedly in numbers towards the end (approx. 2.5/m^2)
Crangon sp.	- noted infrequently
Munida quadrispina	- 1 noted
Lopholithodes sp. (box crab)	- 1 noted
Cancer magister (dungeness crab)	- 2 noted
Hermit crab	- 2 noted
Squalus acanthias (dogfish)	- 2 noted

TABLE 1 (continued)

Faunal Type	Abundance
Rajidae (skates)	- 3 noted
Hydrolagus colliei (ratfish)	- 4 noted
Gadus macrocephalus (grey cod)	- 3 noted
Zoarcidae	- 7 noted
Bathymasteridae	- 8 noted
Sebastes sp.	- 4 noted
Sebastolobus alascanus	- 1 noted
Cottidae	- 1 noted
Agonidae	- 10 noted
Glyptocephalus zachirus (Rex sole)	- 1 noted
Pleuronectidae - adult (sole)	- 11 noted
juvenile (sole)	- 6 noted

Conclusions

The bottom throughout the dive was a fine, soft sediment with few infaunal holes. The bottom fauna was fairly sparse with no forms typical of strong current locations being present. The currents at the time of the dive were flowing from the southeast but were extremely weak. The general conclusion from these observations is that bottom water circulation is limited in this area.

PISCES IV DIVE RECORD

Location: Sechelt - east of Trail Islands   Date: 12 May 1979

Dive No.: 765 (track 2) (Fig. 9)

Observers: H. Nelson, N. Holman

Position:

	Start	Finish
	49°27.10'N	49°27.90'N
	123°46.30'W	123°45.00'W

Depth: 100m

The dive commenced in approximately 100 metres of water just east of the Trail Islands. The submersible proceeded shoreward heading close to magnetic north into an area proposed as a possible discharge site for domestic sewage. The sewage, originating in the Sechelt area, would be processed in a secondary treatment plant prior to discharge. The submersible continued shoreward in the general direction of Selma Park Marina until reaching a depth of 50 metres at which point it reversed course and headed south into deeper water to begin the ascent. The northward track of the dive ended about 180 metres from shore. Readings taken on the Plessey C.T.D. probe during the dive are presented following the observations.

OBSERVATIONS

SURFACE - water clear, few plankton.

DESCENDING - visibility good, a few Ctenophores.

BOTTOM - at 103 metres, visibility 4 to 6 metres.

- the bottom substrate was composed of a thin layer of soft brown mud overlying at least several inches of grey soft sediment. The substrate appeared natural with no characteristics of a reducing sediment. A slight bottom current, estimated at .5 km/hr, was moving in a westerly direction.
- benthos observed on landing consisted of a school of 50 to 60 juvenile hake (Merluccius productus), several ratfish (Hydrolagus colliei) and a few glass sponge, burrowing anemones (Pachycerianthus sp.), pricklebacks, squat lobsters (Munida quadrispina), and orange starfish (Mediaster aequalis).

70m - the Pisces headed shoreward up a slight incline past over an area with a few large rocks and cobbles. This area was characterized by tube polycheates, Serpulids, growing on the rocks, a few green stripe rockfish (*Sebastes elongatus*) and a single quillback rockfish (*Sebastes moliger*) and snail (*Neptunea* sp.).

65m - the slightly inclined, flat soft bottom continued to a depth of 65 metre when the Pisces began moving into deeper water down a slight decline. This decline continued to a depth of approximately 100 metres where the bottom flattened out. For about 30 minutes the Pisces traversed the soft mud bottom with little change in depth.

- during the travel into deeper water the benthos observed in addition to those previously mentioned included sole, ling cod (*Ophiodon elongatus*), large pink anemones, and prawns (*Pandalus platyceros*). The prawns were occupying craters from 10 to 30 centimetres in diameter.

100m - during the first part of the deeper portion of the track a large number of squat lobsters (*Munida quadrispina*) were observed associated with an increase in wood debris. During this period a few prawns, one skate (*Raja* sp.) and no shrimp were observed. Later in the track with no appreciable change in substrate or depth small pink shrimp appeared in large numbers (6 to $8/m^2$), several prawns were observed and the number of squat lobsters decreased significantly. The Dungeness crab (*Cancer magister*) also appeared later in the track.

- the Pisces proceeded from the 100 metre depth up a slight incline to 50 metres depth where the northward progress ended. Benthos during this portion included a few small octopus (*Octopus* sp.), several sea whips, large white and orange anemones (*Metridium* sp.), several flounders, a single sea pen (*Ptilosarcus gurneyi*) and a single sea cucumber (*Parastichopus californicus*).

- at 50 metres depth the Pisces reversed course and headed south into 77 metres of water and surfaced completing the dive.

PLESSEY READINGS

Depth (m)		D.O.	Conductivity	Temp. (^{o}C)
Surface	(1.9)	10.7	25.5	11.9
Descending	8.0	11.5	29.0	11.4
"	20.0	8.5	31.5	7.7
"	40.0	7.3	31.5	7.4
"	70.0	7.7	31.7	7.5
"	90.0	7.9	31.7	7.5
*Bottom (103)		7.6	31.7	7.5
Bottom (50)		7.0	31.5	7.5
Bottom (70)		9.1	31.6	7.5
Ascending 50		8.0	31.5	7.5
" 30		8.8	31.5	7.0
" 10		10.9	31.6	7.0
Surface (2)		12.5	23.5	12.2

* throughout the deeper portion of the dive the readings remained relatively constant.

SUMMARY

The dive area had a natural mud substrate with occasional rock and cobble. The bottom is relatively flat with only slight gradients encountered and a large flat area at a depth of 100 metres. More benthos seemed to inhabit the flat area than at depths from 50 to 80 metres. These were predominately squat lobsters, shrimp, and prawns.

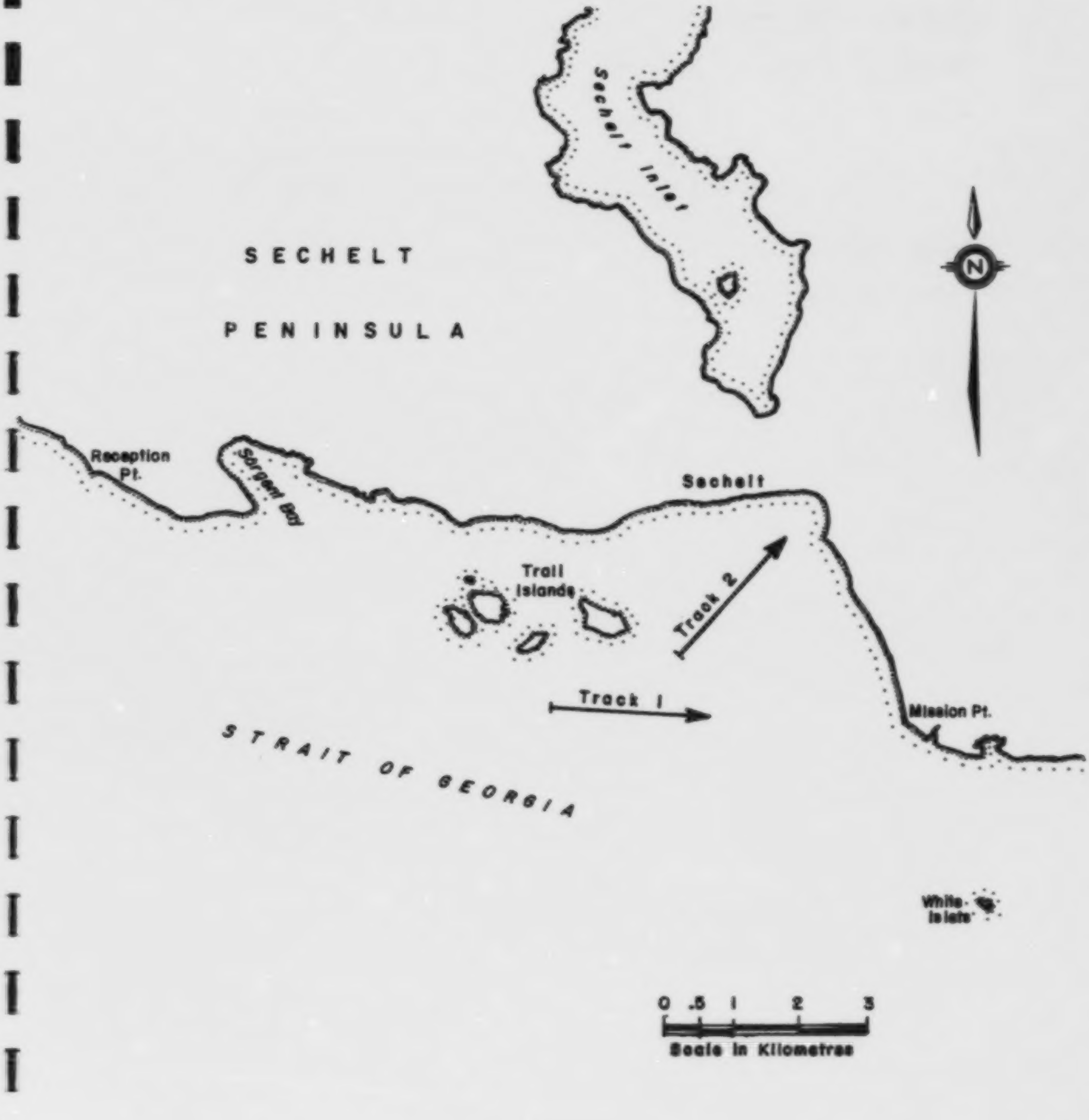
Sechelt Inlet
SECHELT
PENINSULA
N
Reception Pt.
Sargeant Bay
Sechelt
Trail Islands
Track 2
Track 1
Mission Pt.
STRAIT OF GEORGIA
White Islets
0 .5 1 2 3
Scale in Kilometres

FIG. 9 PISCES DIVE TRACKS, SECHELT (1979).

PISCES IV DIVE RECORD

Location: French Creek Date: 17 March 1980

Dive No.: 832 (Fig. 10)

Observers: G. Packman, N. Holman

Position:	Start	Turn	Finish
	49°21.5'N	49°21.53'N	49°21.65'N
	124°21.0'W	124°21.39'W	124°21.30'W

Depth: 65m

Note: No report available

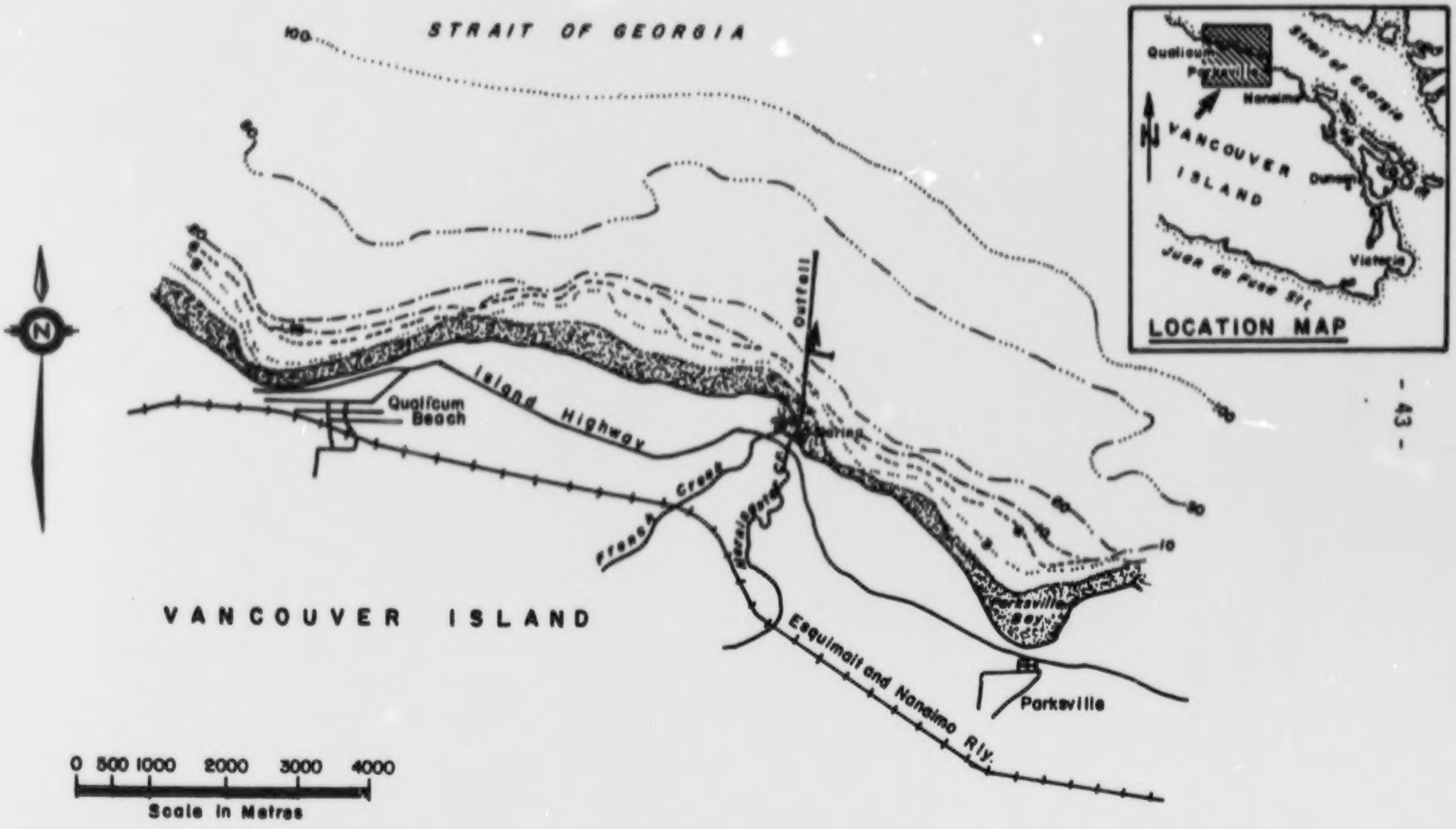
STRAIT OF GEORGIA
100
50
20
10
5
Outfall
Mooring
Qualicum Beach
Island Highway
French Creek
Morningstar Cr.
Parksville Bay
Parksville
Esquimalt and Nanaimo Rly.
VANCOUVER ISLAND
N
0 500 1000 2000 3000 4000
Scale in Metres
Qualicum
Parksville
Nanaimo
Strait of Georgia
VANCOUVER ISLAND
Duncan
Victoria
Juan de Fuca Str.
N
LOCATION MAP

FIG. 10 PISCES DIVE TRACK, FRENCH CREEK SEWAGE OUTFALL (1980).

PISCES IV DIVE RECORD

Location: Five Finger Island (Outfall Inspection) Date: 18 March 1980

Dive No.: 833 (fig 5)

Observers: N. Holman, G. Packman

Position:

Start	Turn	Turn	Finish
49°14.08'N	49°14.15'N	49°14.23'N	49°14.41'N
123°56.46'W	123°56.49'W	123°56.25'W	123°56.09'W

Depth:

Note: No report available

PISCES IV RECORD

Location: Victoria (Macaulay Point)

Date: 20 March 1980

Dive No.: 836 (Fig 11)

Observers: G. Packman, Rogers

Position:

Start	Turn	Finish
48°24.33'N	48°24.36'N	48°23.70'N
123°23.98'W	123°24.46'W	123°24.62'W

Depth: 50m

Note: No report available

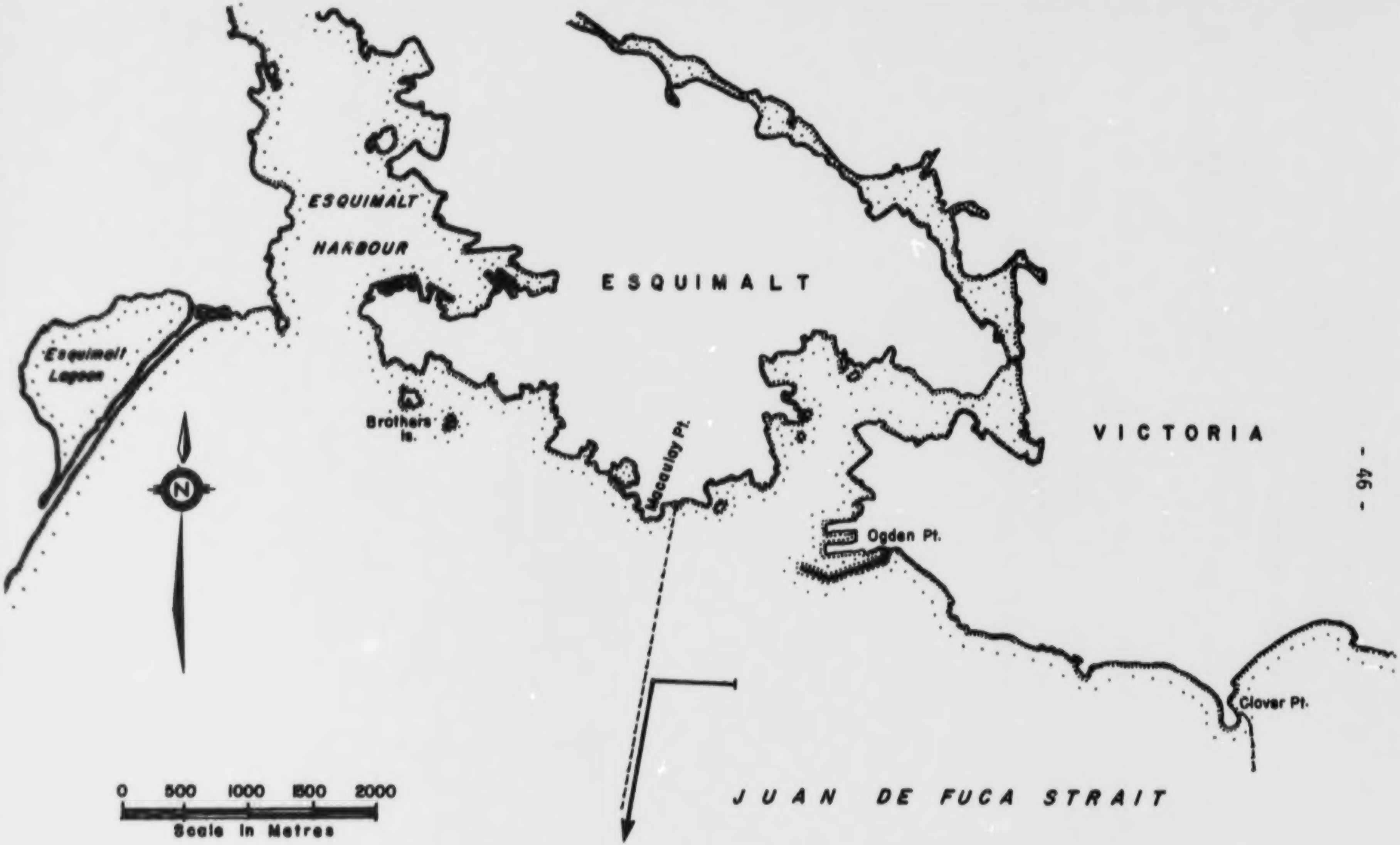
ESQUIMALT
HARBOUR
ESQUIMALT
Esquimalt Lagoon
Brothers Is.
Macaulay Pt.
Ogden Pt.
VICTORIA
Clover Pt.
N
JUAN DE FUCA STRAIT
0
500
1000
1500
2000
Scale in Metres

FIG. 11 PISCES DIVE TRACK, VICTORIA (MACAULAY POINT) 1980.

PISCES IV DIVE RECORD

Location:	Victoria (Macaulay Point)	Date:	20 March 1980

Dive No.: 837

Observers: G. Packman, Klassen

Position:	Start	Finish
	-	-

Depth: 50m

Note: Inspection of outfall.
Currents quite strong.
Dive in vicinity of pipe - can't plot track.

PISCES IV DIVE RECORD

Location:	Victoria (Clover Point)		Date: 21 March 1980
Dive No.:	838 (Fig. 12)		
Observers:	N. Holman, Klassen		
Position:		Start	Finish
		48°23.57'N	48°23.58'N
		123°21.30'W	123°20.05'W

Depth: 87m

Note: Outfall area inspection
- pipe does not extend far so just looked at scour area
- strong current

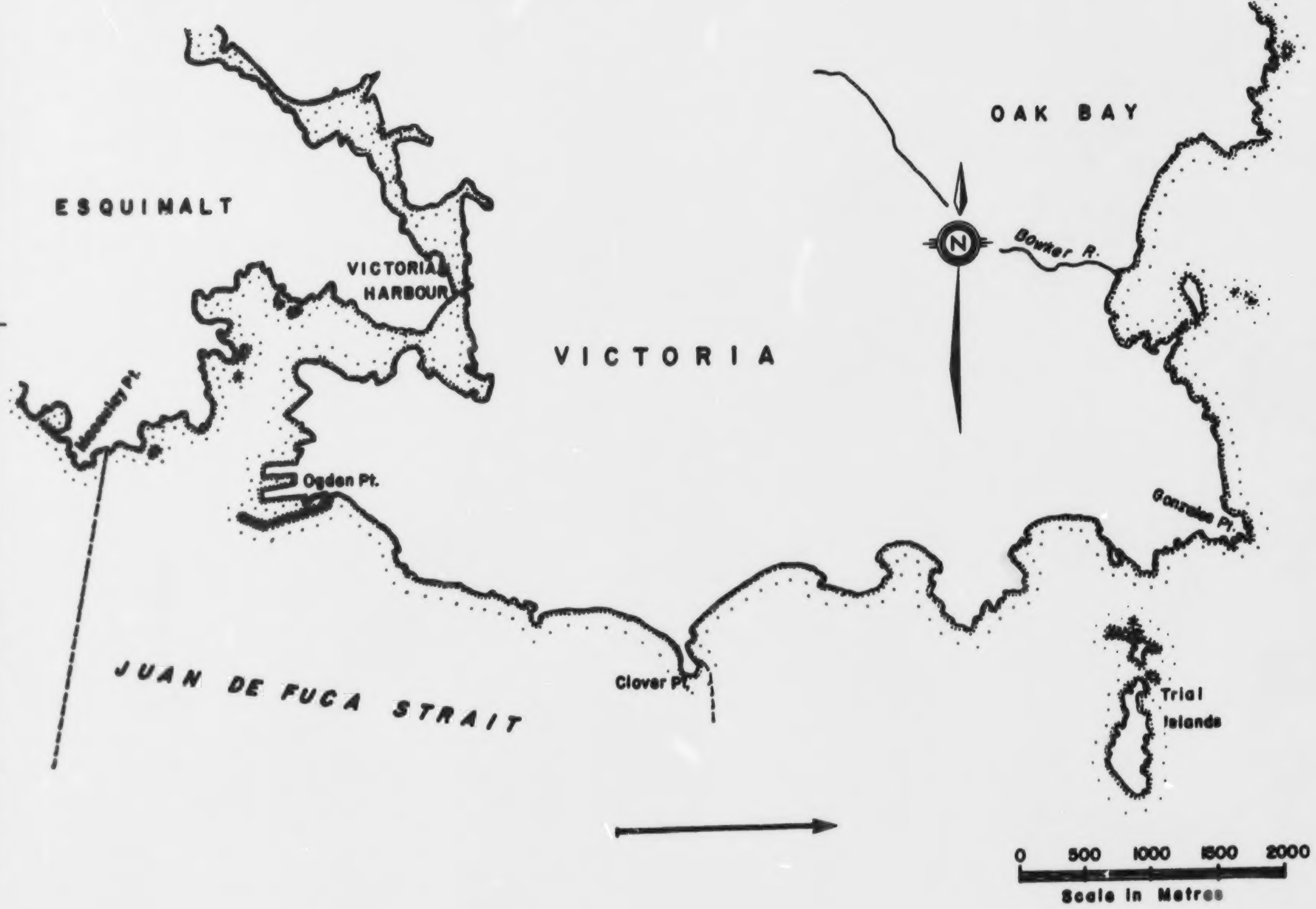
ESQUIMALT
VICTORIA HARBOUR
VICTORIA
OAK BAY
N
Bowker R.
Macaulay Pt.
Ogden Pt.
JUAN DE FUCA STRAIT
Clover Pt.
Gonzales Pt.
Trial Islands
0
500
1000
1500
2000
Scale in Metres

FIG. 12 PISCES DIVE TRACK, VICTORIA (CLOVER POINT) 1980.

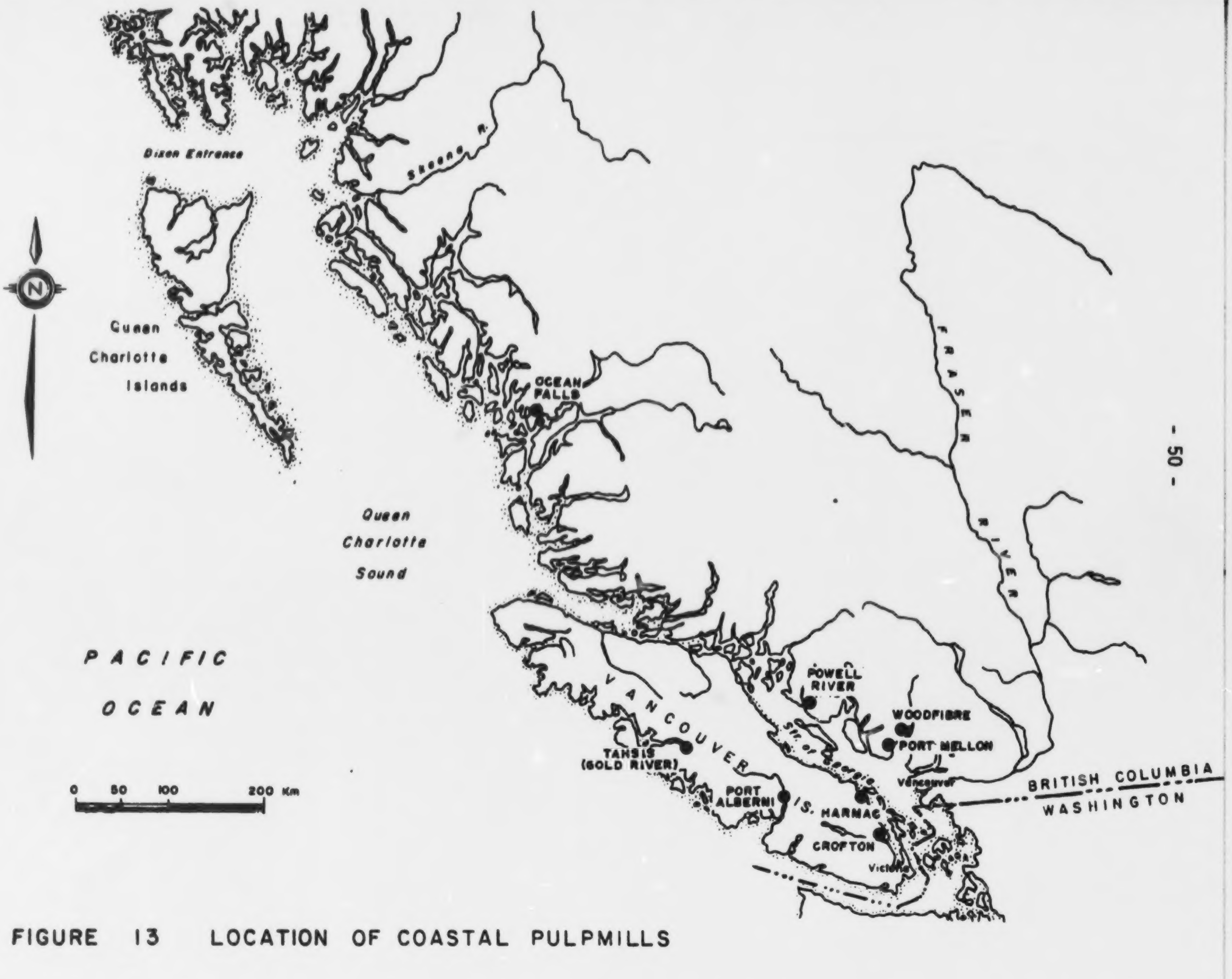
Dixon Entrance
Skeena R.
Queen Charlotte Islands
Queen Charlotte Sound
OCEAN FALLS
FRASER RIVER
PACIFIC OCEAN
VANCOUVER IS.
TAHSIS (GOLD RIVER)
PORT ALBERNI
HARMAC
CROFTON
Victoria
POWELL RIVER
WOODFIBRE
PORT MELLON
Vancouver
Str. of Georgia
BRITISH COLUMBIA
WASHINGTON
0
50
100
200 Km
N

FIGURE 13 LOCATION OF COASTAL PULPMILLS

3.2 PULP MILLS

PISCES IV DIVE RECORD

Location: Howe Sound (Watts Point) Date: 25 August 1976

Dive No.: 463 (track 1) (Fig. 14)

Observers: D. Sullivan, D. Goyette

Position:

	Start	Turn	Finish
track 1	49°40.01'N 123°12.92'W	49°40.12'N 123°12.65'W	49°40.66'N 123°12.62'W
track 2	49°39.78'N 123°12.18'W		49°39.52'N 123°11.85'W

Depth: 200m

DESCENT:

detritial material to 70 metres; below this depth abundant planktonic life; few lantern fish noted.

- Bottom: 200 metres 0935 hours
- Vis; 5m; quickly reduced to 1.5 - 2m
- Course; 050°
- bottom very silty, uneven surface
- few shrimp, bottom covered with mud castings of worms
- 1115 hours 175 metres vis: 60 cm
  Bottom remains the same; species noted
  Eelpouts
  Shrimp
  Bothrocara
  Dasycottus
  slender sole
  Lemon sole (?)
  Brown cat shark
- vis requires aborting dive
- lifted off bottom 50 metres and proceeded north towards shore
- approached cliff 125 metres
- almost vertical, hard rock surface covered with fine layer of silt
  depressions heavily covered with silt, life in these areas somewhat reduced.

- Munida quadraspina and prawns very abundant dominant species
- Cancer and tanner crabs common
- Cloud sponge, starfish, scallops (?) anemones very abundant after 50 metres on ascent
- Small shrimp very abundant after 40 metres Munida still abundant
- Followed rock surface on slow ascent to 5 metres
- Surfaced 1236 hours.

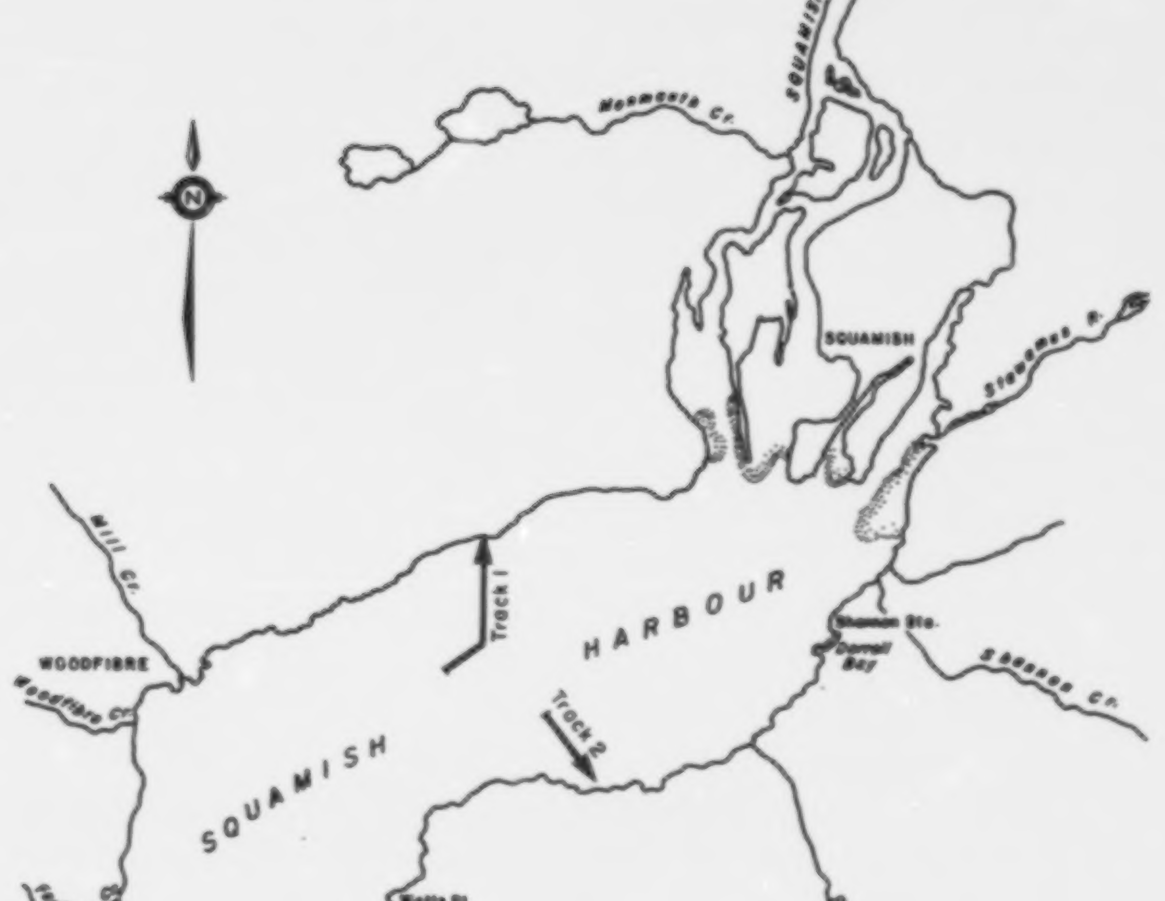
N
SQUAMISH R.
Mamquam Cr.
SQUAMISH
Stawamus R.
Mill Cr.
WOODFIBRE
Woodfibre Cr.
Track 1
HARBOUR
Shannon Sta.
Darrell Bay
Shannon Cr.
Track 2
SQUAMISH
Foulger Cr.
Watts Pt.
Britannia Beach
Britannia Cr.
0 500 1000 2000 3000 4000 METRES

FIG. 14 PISCES DIVE TRACKS, SQUAMISH HARBOUR (1976).

PISCES IV DIVE RECORD

Location: Northumberland Channel
(off Harmac Pulp Mill)

Date: 1 September 1976

Dive No.: 476 (track 7) (Fig. 15)

Observer: D. DeMill

Position:	Start	Finish
	49°08.73'N	49°09.55'N
	123°50.94'W	123°52.13'W

Depth: 80m

Water Column

The water column both at the beginning and end of the dive was quite discoloured (brown) between 60-80 metres.

Speculation was made as to whether this was pulp mill effluent moving up channel from Harmac Pulp Mill, in the opposite direction from which it is supposed to flow.

Bottom Characteristics

Initially the bottom was composed of mud, however rock piles were encountered which because of their rock composition and spatial concentration appeared to have been dumped into the channel.

A few scattered rocks and logs were discovered on the mud bottom.

Benthic Fauna

Mud Bottom

A considerable amount of life was observed both on top of the mud and in it.

The predominant infaunal lifeforms appeared to be bamboo worms (*Maldanidae*), burrowing anemones (*Pachycerianthis* sp.) burrowing holothurians (possibly *Leptosynapta* but this is only speculation) and what appeared to be *Terebellidae* dwelling in holes in the mud.

The epifauna observed consisted of nemerteans, a sea pen (Stylatula elongata), sunstars (Pycnopodia helianthoides), polychaete worms (Polynoidae), pink shrimp (Pandalus borealis), prawns (P. platyceros), squat lobsters (Munida quadraspina), crangon, Dungeness crabs (Cancer magister), unidentified Brachyurans, eelpouts (Zoarcidae), grey cod (Gadus macrocephalus), rockfish (Sebastes sp.) and small sole (Pleuronectidae).

Rocky Ledge

Fauna in the rocky area was basically epifauna as would be expected.

The fauna present included siliceous sponges (Aphrocallistes sp. and Rhabdocallistes sp.), a variety of sea anemones including Metridium senile in great abundance squat lobsters (Munida quadraspina), prawns (Pandalus platyceros) which were less abundant than on the mud bottom.

Summary

The most startling observation on this dive was the presence of what appeared to be pulp mill effluent in the midwater in the northwestern end of Northumberland Channel. According to calculations made prior to pulp mill expansion all of this effluent should have moved down through Dodd Narrows. On the whole a great amount of life was observed on this dive, probably owing to the constant movement of water through Dodd Narrows.

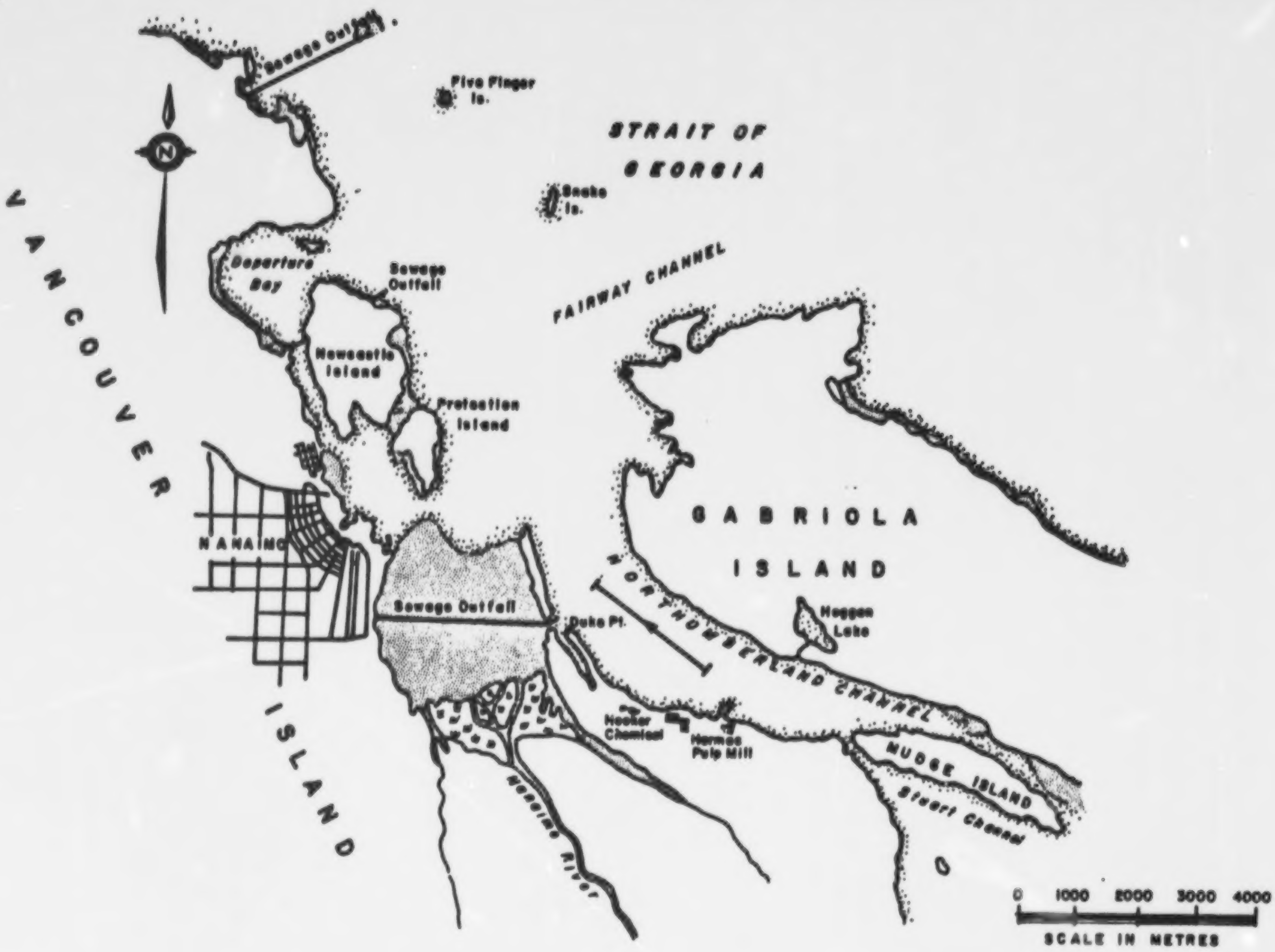
Sewage Outfall
Five Finger Is.
STRAIT OF GEORGIA
N
Snake Is.
Departure Bay
Sewage Outfall
Newcastle Island
Protection Island
FAIRWAY CHANNEL
VANCOUVER ISLAND
NANAIMO
GABRIOLA ISLAND
Sewage Outfall
Duke Pt.
NORTHUMBERLAND CHANNEL
Hoggan Lake
Hooker Chemical
Harmac Pulp Mill
MUDGE ISLAND
Stuart Channel
Nanaimo River
0
1000
2000
3000
4000
SCALE IN METRES

FIG. 15 PISCES DIVE TRACK, NORTHUMBERLAND CHANNEL (off HARMAC PULP MILL) 1976.

PISCES IV DIVE RECORD

Location: Cousins Inlet (Ocean Falls) Date: 20 October 1976

Dive No.: 512 (track 1) (Fig. 16)

Observers: N. Holman, R. Hoos

Position:	Start	Turn	Finish
	52°21.08'N	52°21.18'N	52°21.05'N
	127°42.34'W	127°42.85'W	127°42.90'W

Depth: 60m

Location: Cousins Inlet (Oceans Falls) Date: 20 October 1976

Dive No.: 513 (track 2) (Fig. 17)

Observers: N. Holman, G. Packman

Position:	Start	Turn	Turn	Turn	Turn	Finish
	52°19.90'N	52°19.92'N	52°19.97'N	52°20.00'N	52°20.08'N	52°20.10'N
	127°44.43'W	127°44.28'W	127°44.45'W	127°44.50'W	127°44.65'W	127°44.71'W

Depth: 70m

Track 1

The first dive was located just off the mill as indicated in Figure 1. On descent, a layer heavily laden with fibre was found to exist in the top two metres of the water column. Below this the water cleared somewhat, still however remaining heavily laden with fibre. The only planktonic forms apparent in the water column were ctenophores. Just above the fibre mat, the water had a milky appearance reducing visibility to the order of 1.5m.

The fibre bed was initially white and had the appearance of a field of snow, undulating, with an occasional log projected (Plate 1). It was apparent that the mat was not greatly compacted, as shock waves would ripple through it if disburbed. As the dive progressed, grey and black patches became apparent on the surface of the fibre bed where the underlying anaerobic decomposition had for some reason been exposed.

No life was initially apparent on the fibre bed itself, however sea anemones (Metridium senile) and ascidians (Ascidia peritropa) were present on logs projecting from the bed. In the area where grey and black patches were observed, tube dwelling polychaetes (Capitella sp.) were observed, extending above the surface of the fibre, in the black patches. A few paochers (Agonidae) and a tomcod (Microgadus proximus) were also observed.

As the dive progressed up a cliff face off Coolidge Point, more life became apparent. The life forms observed here included coon-stripped shrimp (Pandalus danae) and Cancer productus. However, throughout the dive there was an obvious absence of such typical faunal forms as squat lobsters (Munida quadraspina), ratfish (Hydrolagus colliei), dogfish (Squalus acanthias) and rockfish (Sebastes sp.).

Track 2

A second dive was completed on 20 October at a location further down the inlet from the first. On descent, the water column was again observed to be of a milky nature from the presence of fibre particles in the water, however this was not as apparent as in the previous dive. The only zooplanktonic forms observed were again ctenophores.

The bottom at the point of descent appeared to be composed of mud and detritus which may have been covering remnants of the old fibre bed, presumed to have been layed down when the old sulphite mill was in operation. Upon moving off from this point, branches and logs were observed protruding from the bottom. The bottom was observed to change to one in which patches of black hydrogen sulphide ooze (covered in part by a white bacterial slime) appeared in the detrital mud bottom. Extensive patches of small wood chips were also observed. A cliff was encountered on the west side of the inlet. This was climbed, the terrain at the top being composed of rocks and small boulders interspersed with woodships.

Benthic fauna was abundant throughout the dive. The most abundant form throughout the first portion was a small, thin, white sea pen which reached concentrations of up to 50/metre^2. This lifeform was observed on all bottom types except the rocky terrain. Other major lifeforms observed on the "recolonized fibre bed" were poachers (Agonidae), ronquils (Bathymasteridea), pricklebacks (Stichaeidae), pink shrimp (Pandalus borealis), burrowing anemones (Pachycerianthus sp.), and sedentary polychaetes such as Cirratula sp.

The rockface was heavily populated with sea anemones (*Metridium senile*), sea urchins (*Strongylocentrotus droebachiensis*), squat lobsters (*Munida quadraspina*), hermit crabs (*Pagurus* sp.) and spider crabs. Many burrowing holothurians, very similar in appearance to *Chirodota* sp. were observed in the sediments at the summit of the rockface.

Conclusions

It was the general concensus of the observers present (N. Holman, R. Hoos, G. Packman) that the vicinity of the second dive (Track 2, Figure 17) would be unsuitable for ocean dumping due to the apparent recolonization in this area. It was felt that the area surrounding Track 1 would be suitable for this purpose however, as the bottom was completely covered with fibre, life subsequently being non-existent. This condition will probably remain as it is at present as long as the mill is in operation with the same degree of fibre loss.

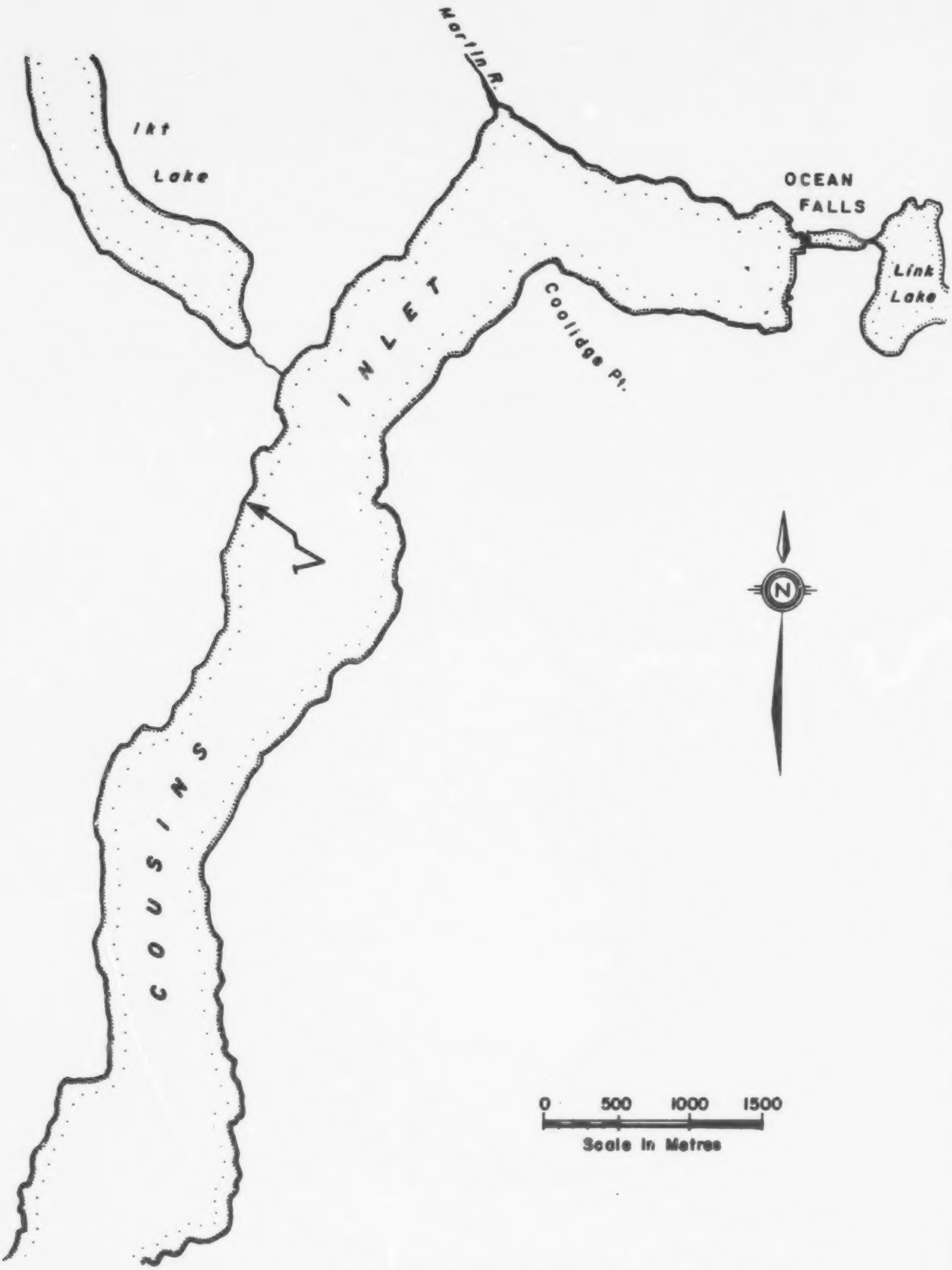
Martin R.
Ikt Lake
OCEAN FALLS
Link Lake
INLET
Coolidge Pt.
COUSINS
N
0
500
1000
1500
Scale in Metres

FIG. 16 PISCES DIVE TRACK, COUSINS INLET (1976).

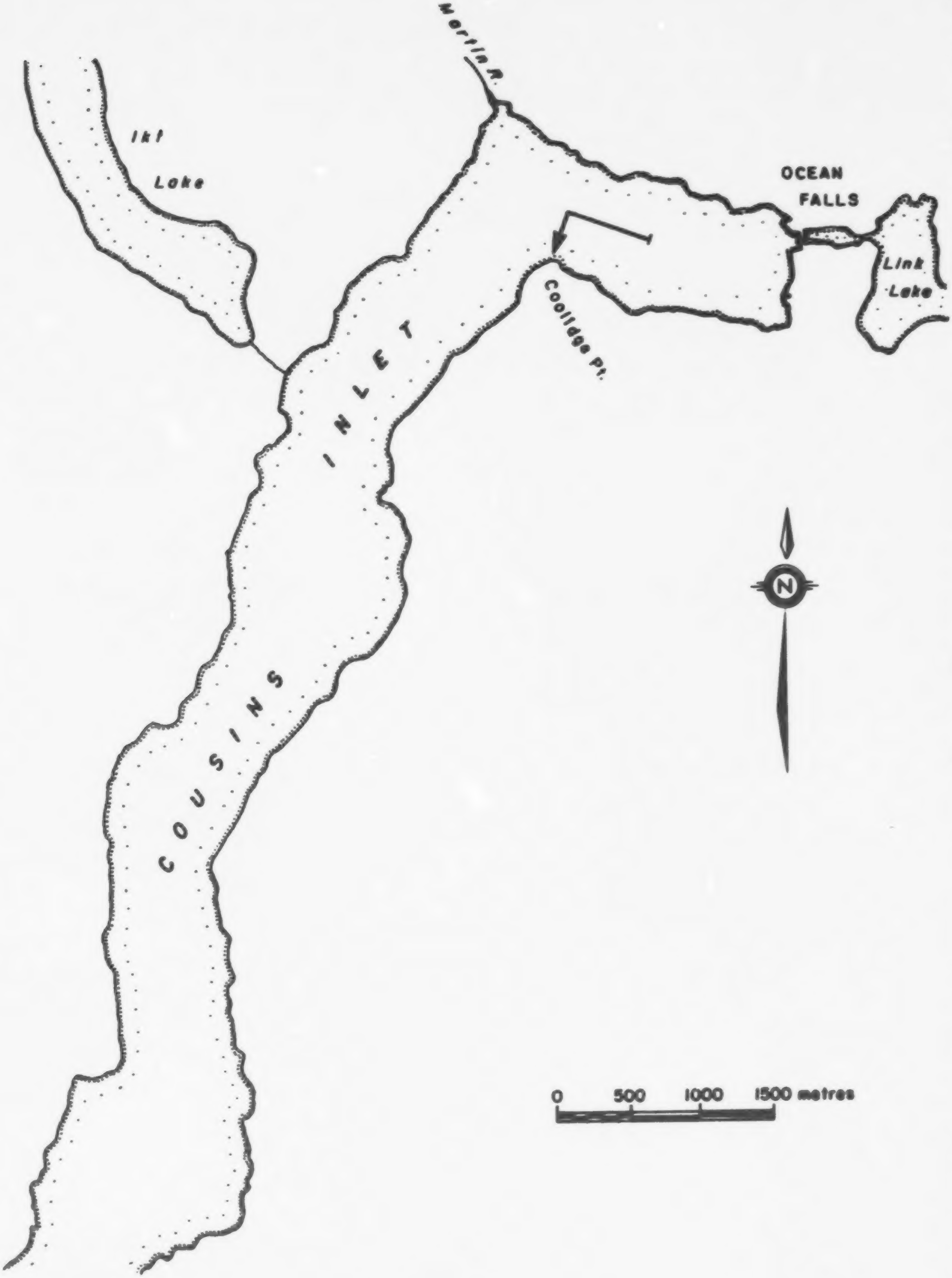
Martin R.
Ikt
Lake
OCEAN
FALLS
Link
Lake
Coolidge Pt.
COUSINS INLET
N
0
500
1000
1500 metres

FIG. 17 PISCES DIVE TRACK, OCEAN FALLS (1976).

PISCES IV DIVE RECORD

Location: Prince Rupert (Chatham Sound) Date: 22 October 1976

Dive No.: 516 (Fig. 18)

Observers: N. Holman, G. Packman

Position:	Start	Finish
	54°11.47'N	54°11.49'N
	130°23.22'W	130°23.88'W

Depth: 115m

Note: No report available

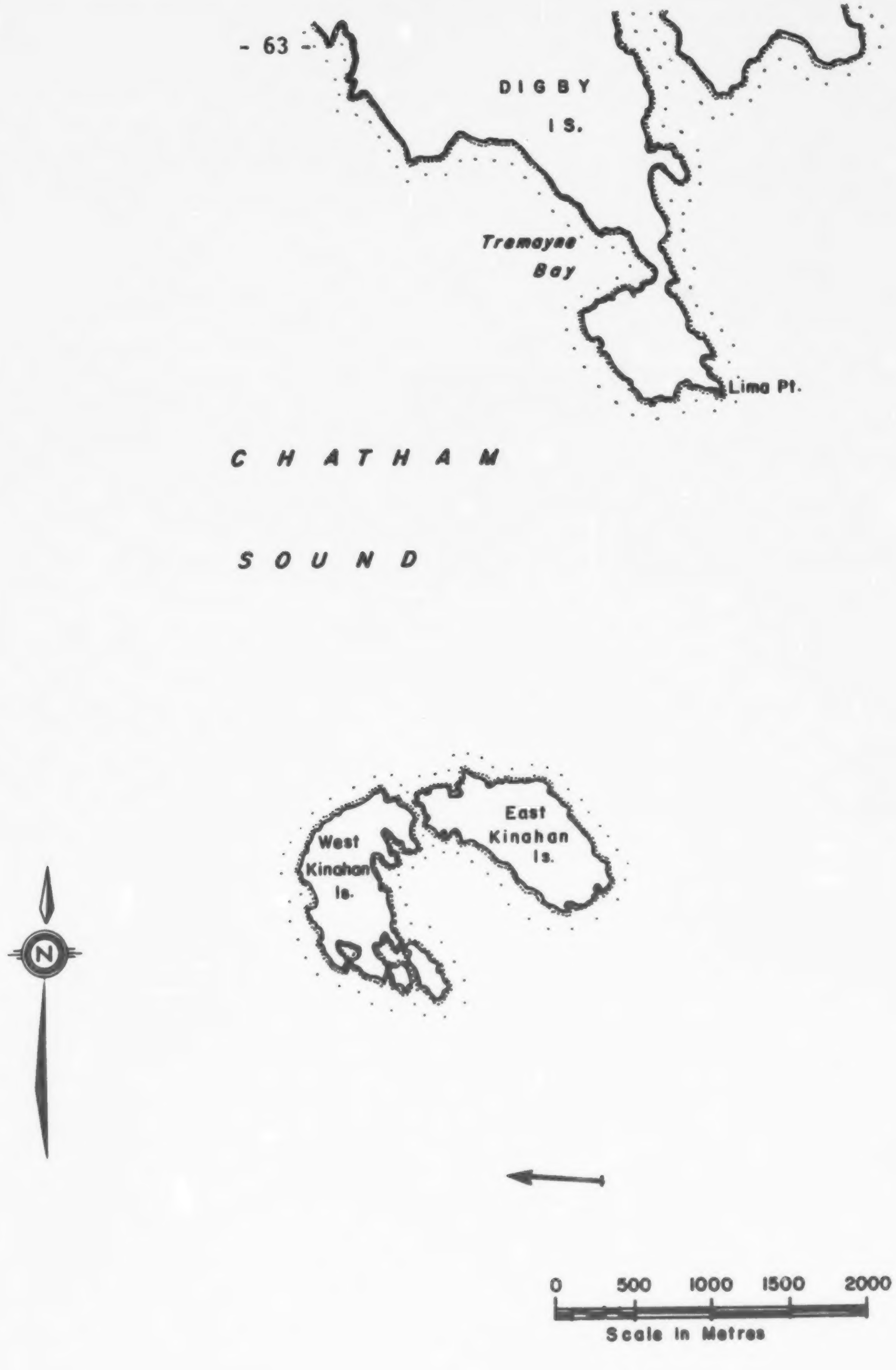
DIGBY IS.
Tremayne Bay
Lima Pt.
CHATHAM SOUND
West Kinahan Is.
East Kinahan Is.
N
0
500
1000
1500
2000
Scale in Metres

FIG. 18 PISCES DIVE TRACK, CHATHAM SOUND (1976).

PISCES IV DIVE RECORD

Location: Prince Rupert (Chatham Sound) Date: 22 October 1976

Dive No.: 517 (Fig. 19)

Observers: N. Holman, G. Packman

Position:	Start	Turn	Finish
	54°14.42'N	54°14.48'N	54°14.45'N
	130°28.05'W	130°28.49'W	130°29.10'W

Depth: 70m

Note: No report available.

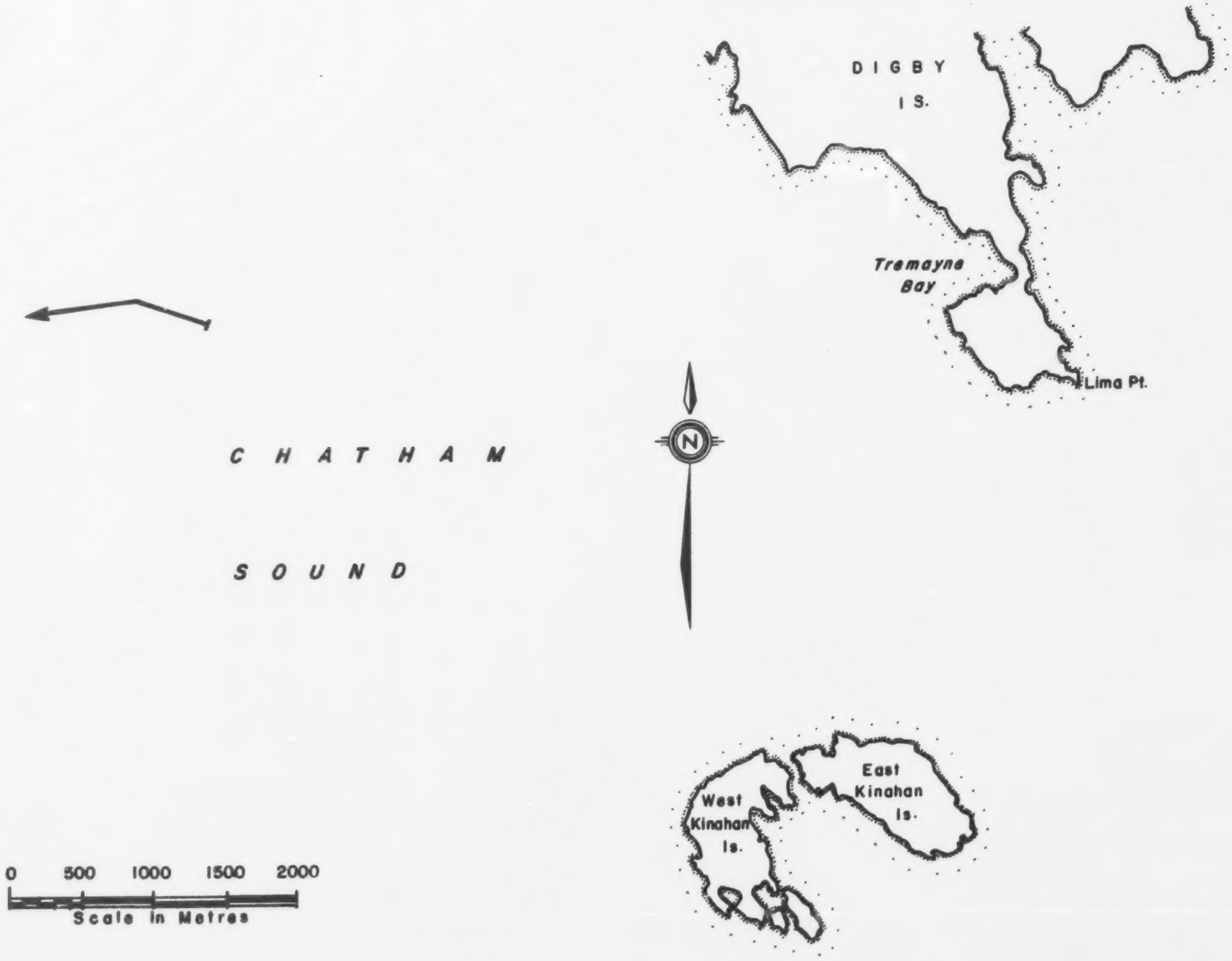
DIGBY IS.
Tremayne Bay
Lima Pt.
N
CHATHAM
SOUND
East Kinahan Is.
West Kinahan Is.
0
500
1000
1500
2000
Scale in Metres

FIG. 19 PISCES DIVE TRACK, CHATHAM SOUND (PRINCE RUPERT). 1976.

PISCES IV DIVE RECORD

Location: Satellite Channel Date: 8 March 1977

Dive No.: 591 (Fig. 20)

Observers: R. Hoos, G. Packman

Position:	Start	Finish
	48°42.55'N	48°42.88'N
	123°29.80'W	123°30.05'W

Depth: 65m

Observations: Descending

- at 25 metres. Group of small salmon noted.
- Plankton cloud including Euphausids and Chaetognaths at 75m.
- Soft silty bottom. 8-12 cm herring moving about. Visibility ca. 3m. Current from 090° at approximately 1.85 km/hr.
- Bottom at 65m. Moving off on course 030° to Saltspring Island. Bottom flat. A few Rossia noted in 1st few minutes. Brittlestars noted. Herring seen regularly.
- a few large Mediaster and a large Luidia noted on the flat sandy bottom. No shrimp or prawns seen at this time.
- Occasional Moonsnail. Visibility 2-3m. Fine sediment in water column.
- Grab sample using Eckman sampler penetrated 12 cm.
- Climbing slope at 65m. Some Neptunea noted.
- Pricklebacks (approx. 20 cm. long) and a few small sole observed.
- 1 Skate, 2 cod, 2 prickleback observed in 11 cm^2.
- 50 metres. Considerably more life at this depth. Visibility improved. 72 cm. slope. Solaster, numerous brittlestars, Mediaster, sea anemones, pricklebacks, quite a bit of algae and bryozoan life noted.

Observations: (cont.)

- 35m. Orange sea pen, great variety of starfish including *Pycnopodia*, *Dermasterias*, *Solastar*, *Evasterias*, *Orthasterias*, *Mediaster*, *Crossaster*. Noted.
- Algae found from 35m to surface.

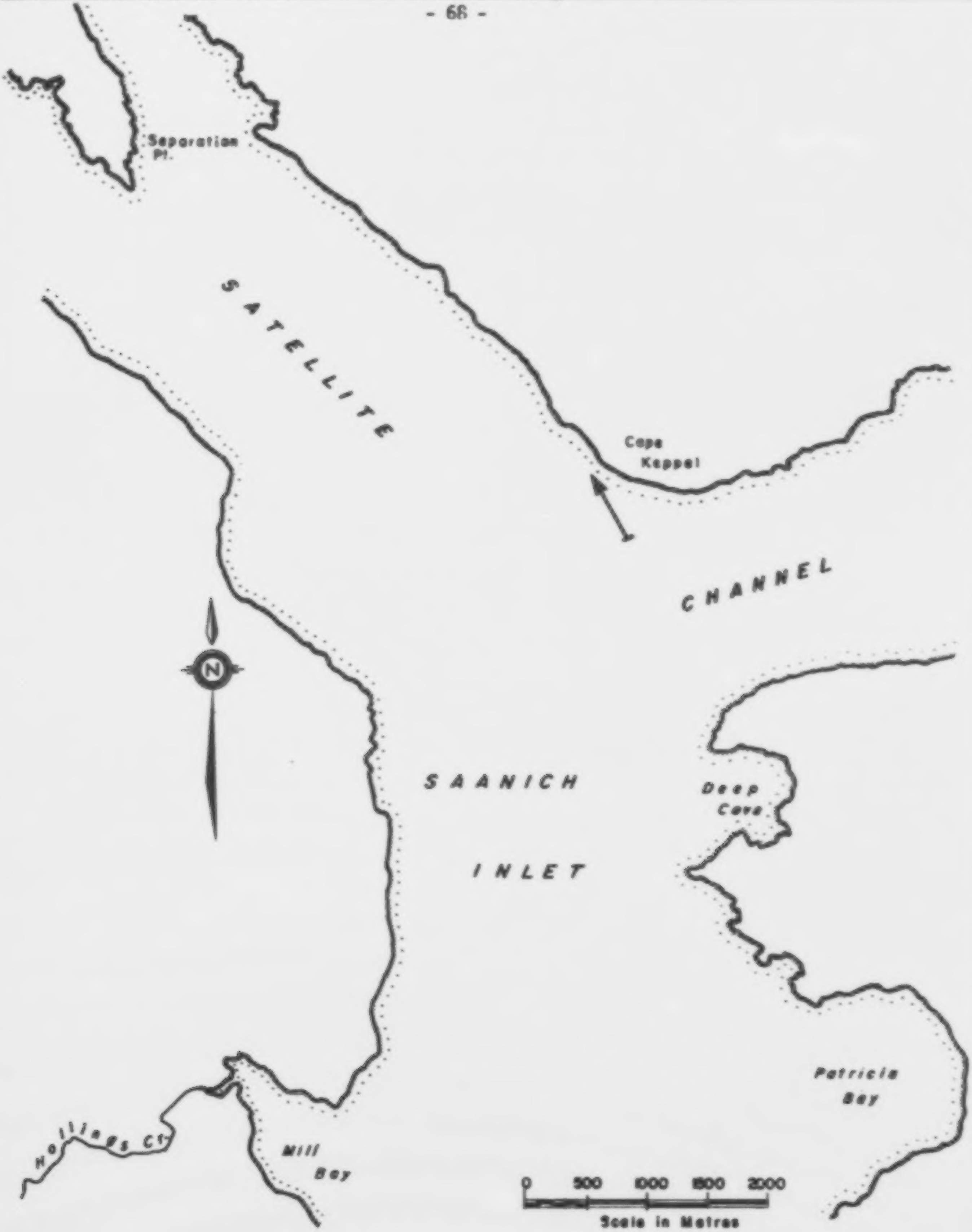
Separation Pt.
SATELLITE
Cape Keppel
CHANNEL
N
SAANICH
INLET
Deep Cove
Patricia Bay
Hollings Cr.
Mill Bay
0 500 1000 1500 2000
Scale in Metres

FIG. 20 PISCES DIVE TRACK, SATELLITE CHANNEL (CHEMAINUS). 1977

PISCES IV DIVE RECORD

Location: Alberni Inlet

Date: 11 March 1977

Dive No.: 593 (Fig. 21)

Observers: R. Hoos, G. Packman

Position:	Start	Finish
	49°02.75'N	49°03.00'N
	124°50.90'W	124°50.70'W

Depth: 300m

Observations:

Descending

- Brown surface water, possibly attributable to the pulp mill complex at Alberni.
- Visibility poor at 20m.
- A few euphausids at 60m.
- Euphausid layer cases by 90m. Ctenophores, copepods present.
- *Pasiphaea pacifica* concentrated at 175m. A few very large ctenophores and lantern fish in the background.
- Greater concentration of lantern fish (Myctophidae) at 225m.

Bottom

- Bottom at 270m. Ratfish, some shrimp. Dropped into a school of hake. The hake stirred up dust. Took about 15 minutes of manoeuvring to get away from the poor visibility created.
- Sediment very fine and soft. Visibility 3 - 3.5m. A few smelt, *Crangon* present.
- Ratfish, hake, dogfish, sole, red snapper, eel pouts seen from time to time.
- 295m. Visiblity approx. 3m. Sole and turbot seen. Several "PMT" type prawns noted.

Observations: - Position fixed at 300m - 49°3.0'N, 124°50.7'N
(continued) - Ascent from 300m to surface.

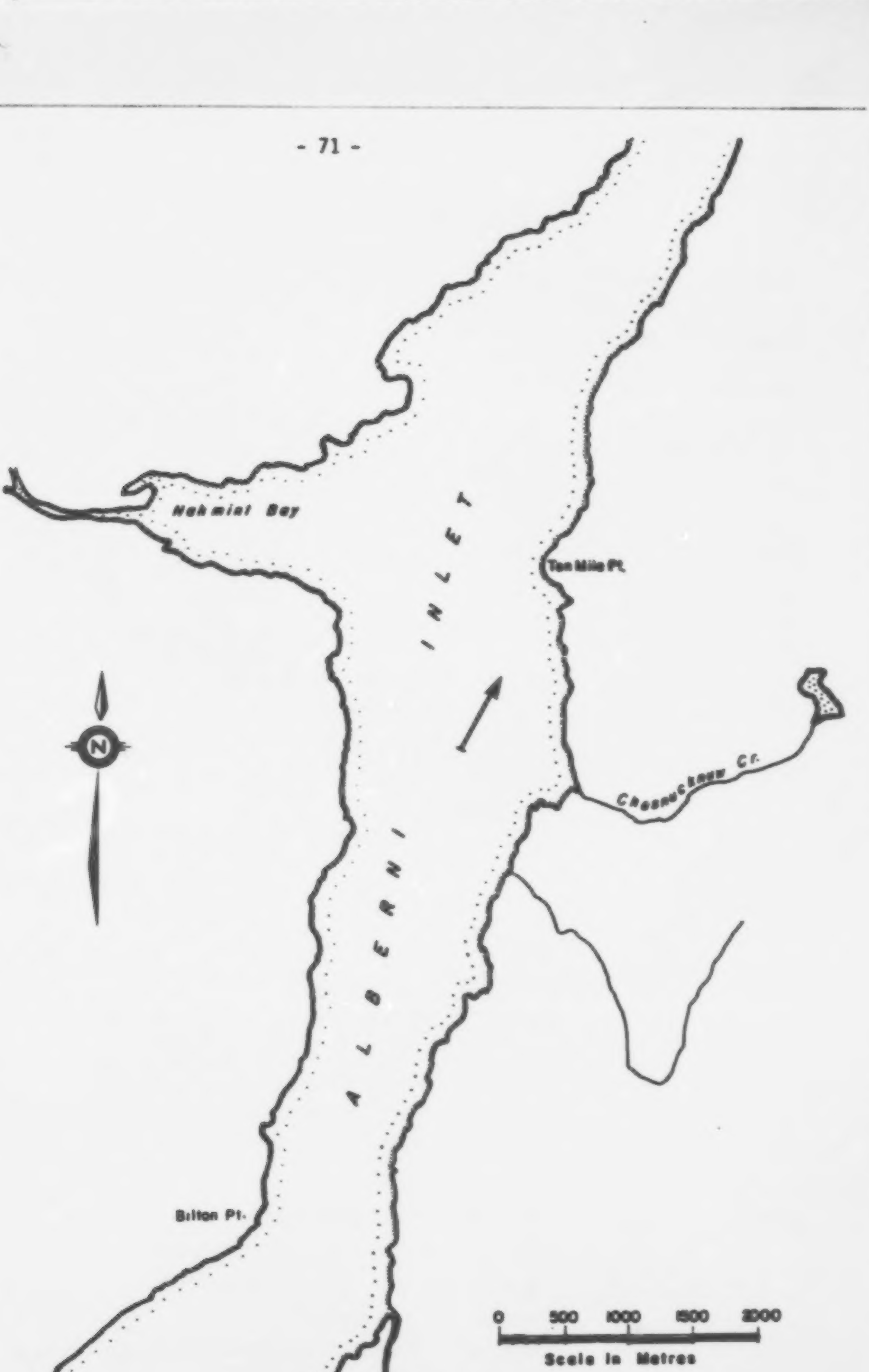
Nahmint Bay
Ten Mile Pt.
INLET
ALBERNI
N
Chesnucknuw Cr.
Bilton Pt.
0
500
1000
1500
2000
Scale in Metres

FIG. 21 PISCES DIVE TRACK, ALBERNI INLET (1977).

PISCES IV DIVE RECORD

Location: Muchalat Inlet (off Gold River Pulp Mill)

Date: 12 March 1977

Dive No.: 595 (Fig. 22)

Observers: H. Nelson, G. Packman

Position:

Start	Finish
49°40.25'N	49°40.60'N
126°06.70'W	126°80.31'W

Depth: 360m

Observations:

Descending

- much detritus, white particles in stands in suspension.
- pelagic amphipods, ctenophores

50m
- decrease in suspended matter
- siphonophores, euphausids

175m
- many pelagic amphipods
- *Pasiphaea pacifica*
- milky turbid water layer just off bottom

Bottom

310m
- visibility approximately 2 metres
- flat bottom, substrate dark fine sediment, fine wood particles.
- bottom epibenthic area inhabitated by many amphipods course 270°, gradually sloping bottom
- little or no current
- several logs and branches buried to varying degrees with fine sediment. No benthic life except amphipods (white in colour)

325m
- after covering approximately .5km of bottom, no life observed other than amphipods.
- no obvious signs of dumping activity
- heading 325°, towards diffuser
- often pass clumps of amphipods (10 to 50) presumably feeding on pieces of detritus.
- heading 020°towards diffuser

360m	- no change
	- large clumps of light coloured suspended matter just off bottom.
340m	- base of steep rock cliff with clumps of fine fibres accumulating in the crevices
	- rock face devoid of life
	- water becoming murky, visibility decreased, fibre suspended in water column.
265m	- observed first Munida quadrispina
	- white slime (bacterial) in pockets or crevices
	- clumps of fibre rolling down rock face
250m	- anemone
	- tube polychaetes, squat lobster
225m	- many zooplankters, amphipods and copepods
	- small shrimp
	- amphipods very abundant in fibre mat and water column
125m	- many polychaete tubes
100m	- visibility improved to approximately 10 metres
95m	- several Metridium sp., nudibranch, cup coral
85m	- Pandalus platyceros (prawn), Hydrolagus colliei (rat fish)
50m	- rat fish
45m	- visibility decreasing
	- large pieces of fibre on shelves of cliff
40m	- rat fish, Metridium sp., tube polychaetes
35m	- visibility poor
	- schools of rock fish around diffuser pipe
	- pipe open ended, covered with Metridium sp., as are supporting cables
	- visibility above the pipe quite good
20m	- begin ascent from end of pipe
	- surfaced approximately 50m south of shore sewer box

SUMMARY: A marked lack of benthic life in this area, with the exception of amphipods which seem to thrive. Since the bottom is covered by a mat of fibre the natural decomposition of this organic matter may have contributed

SUMMARY (continued)

to the anoxic bottom environment. This anoxia was revealed by results of the dissolved oxygen survey done in the area after completion of the dive. The unusual absence of life on the steep rock face below the diffuser pipe may indicate the direct environmental impact of the effluent discharge. During the dive, stressed rock fish, *Sebastes entomelas* were collected from the diffuser area by cree off the ship.

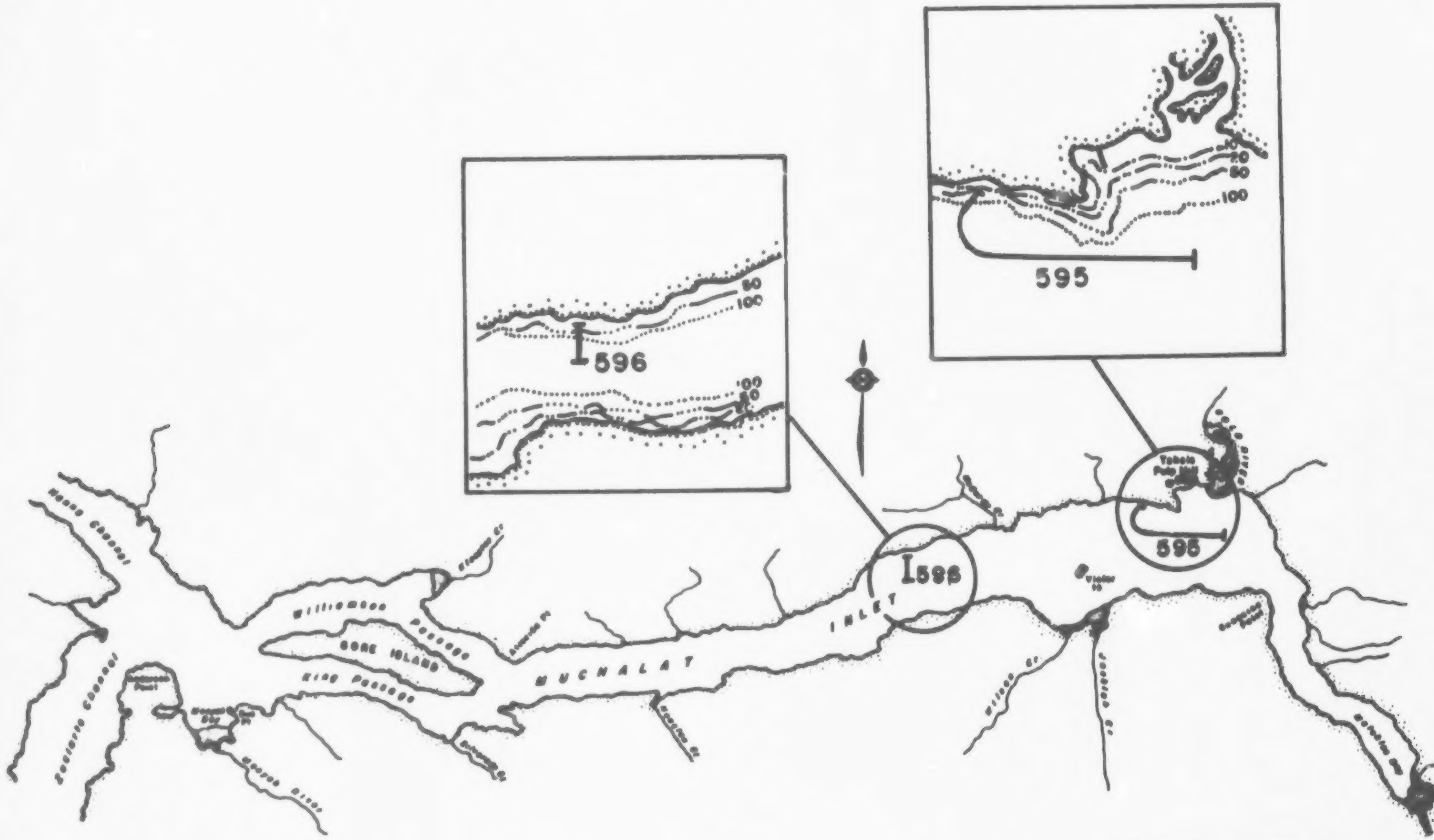
10
20
50
100
595
50
100
596
100
50
I596
595
Gold River
MUCHALAT
INLET
Williamson Passage
Gore Island
King Passage
Zuciarte Channel
0 500 1000 2000 3000 4000 5000
SCALE IN METRES

FIG. 22 PISCES IV DIVE LOCATIONS, MUCHALAT INLET (1977).

PISCES IV DIVE RECORD

Location: Tahsis Inlet　　Date: 13 March 1977

Dive No.: 597 (track 14) (Fig. 23)

Observers: G. Packman, D. Sullivan

Position:	Start	Finish
	49°51.48'N	49°51.60'N
	126°39.42'W	126°40.20'W

Depth: 140m

OCEANOGRAPHIC CHARACTERISTICS

Depth	Temperature	Salinity	D.O.	% Saturation
0	7.25	14.31	11.5	107.21
2	7.76	22.51	10.0	99.33
5	8.45	28.07	9.3	97.40
10	8.60	29.33	8.5	90.07
25	8.67	30.1	7.7	82.16
175	8.38	31.92	1.25	13.41

Watercolumn

A freshwater mixing layer extending to a depth of 15 metres was observed, below which the watercolumn was very clear with little detritus present. At 100 metres siphonophores and euphausids were observed while at 125 metres pelagic amphipods were present. Zooplankton concentrations increased as the bottom was approached, with Pasiphea pacifica, Copepoda and Pteropoda being present. On the bottom the visibility was of the order of 35m.

Bottom

The bottom consisted of a mud substrate appearing to contain a fair quantity of woodwastes. As the dive progressed the concentration of woodwastes increased and patches of black hydrogen sulphide ooze covered in a white bacterial slime were observed. Towards the end of the dive a typical rock cliff was climbed.

Fauna

The fauna observed on the bottom was reasonably typical of a B.C. inlet. Animals observed included Munida quadrispina, Crangonidae, eelpouts, small Pleuronectidae, Agonidae, Hydrolagus colliei and small shrimp. The one outstanding feature of the faunal composition was the presence of a large number of empty shells of the bivalve Solemya johnsonii.

The cliff face climbed towards the end of the dive was typical in its faunal composition. The animals observed included the cloud sponge (Aphrocallistes sp.), burrowing anemones (Pachycerianthus sp. on small mud filled plateaus), sea anemones (Metridium senile), cup corals, calcareous tuberculous polychaetes, a scale worm (Polynoidae, at base of cliff), jingle shells (Pododesmus cepio), various types of starfish including Pseudarcaster sp., squat lobsters (Munida quadrispina), prawns (Pandalus platyceros), coon-striped shrimp (Pandalus danae), various unidentified shrimp, Psolus chitinoides, sole (Pleuronectidae), rockfish (Scorpaenidae), poachers (Agonidae) and solitary ascidians.

Comments

Evidence of past dumping activity was observed in the form of wood debris mixed into the sediments and patches of hydrogen sulphide ooze covered in a white bacterial slime on the surface. Damage to the benthic epifauna appeared limited, however there was little evidence of benthic infauna.

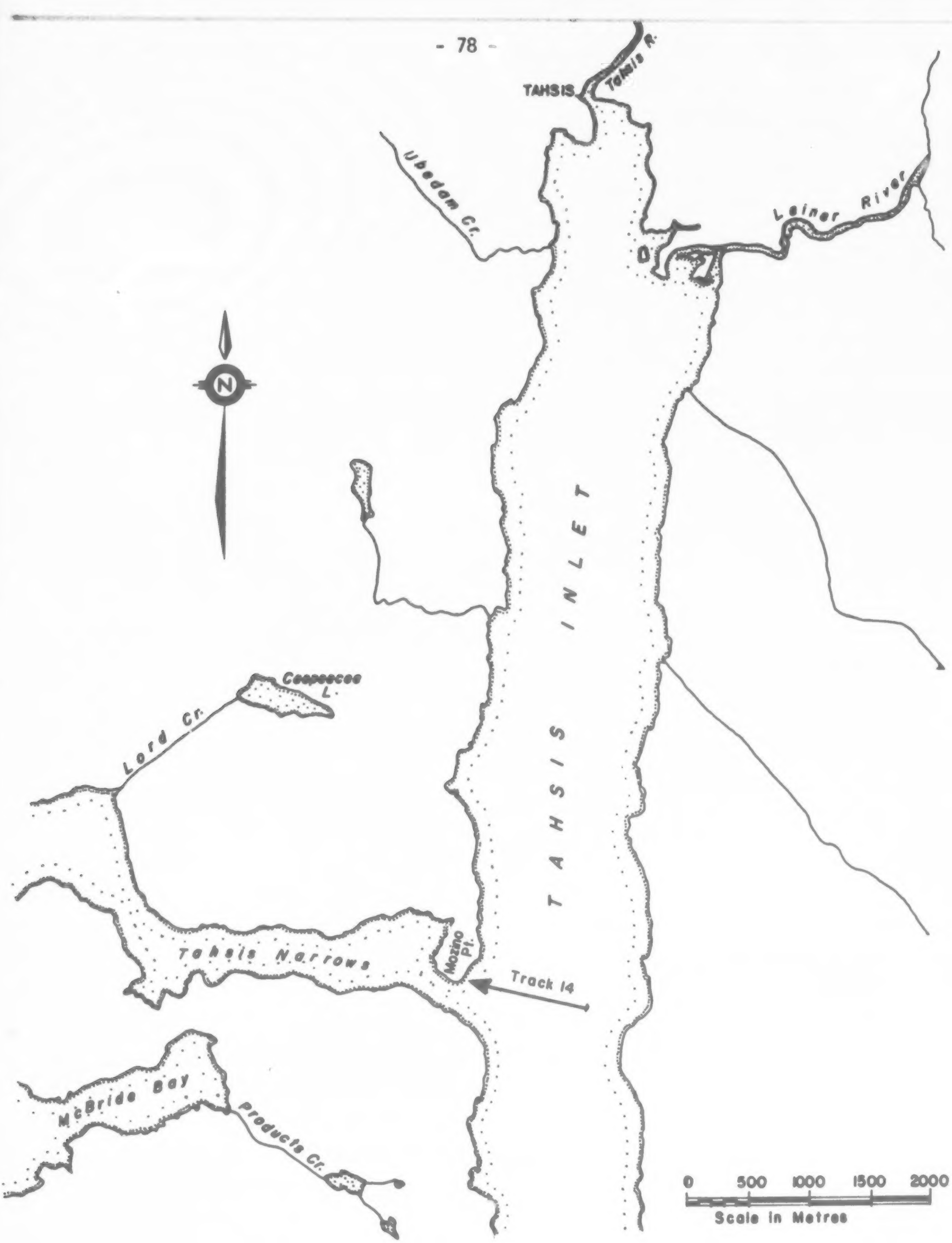
TAHSIS
Tahsis R.
Ubedam Cr.
Leiner River
D
N
TAHSIS INLET
Ceapeecee L.
Lord Cr.
Tahsis Narrows
Mozino Pt.
Track 14
McBride Bay
Products Cr.
0 500 1000 1500 2000
Scale in Metres

FIG. 23 PISCES DIVE TRACK, TAHSIS INLET (1977).

PISCES IV DIVE RECORD

Location: Tahsis Inlet Date: 13 March 1977

Dive No.: 598 (track 15) (Fig. 24)

Observers: G. Packman, H. Nelson

Position:	Start	Finish
	49°53.00'N	49°52.92'N
	126°39.60'W	126°39.98'W

Depth: 140m

OCEANOGRAPHIC CHARACTERISTICS

Depth	Temperature	Salinity	D.O.	% Saturation
0	7.25	20.69	10.3	99.89
2	7.53	20.39	10.2	99.41
5	7.35	26.37	9.0	90.75
10	8.48	28.8	8.5	89.50
25	6.65	29.77	7.5	76.01
50	9.02	30.78	4.35	47.01
200	8.87	31.5	2.65	28.68

Watercolumn

On descent a halocline was apparent at approximately the 20 metre depth. Light penetration was found to extend to a depth of approximately 85 metres below which a zooplankton layer was evident. Zooplankton became thick again just off the bottom at 135 metres.

Visibility on the bottom at 140 metres was approximately 7 metres.

Bottom

The bottom upon descent was primarily mud with some woodwastes mixed into the substrate. After a period of time running along the bottom, patches of black ooze were apparent showing through the mud surface. Heavy concentrations of woodwastes were soon observed as well as a piece of machinery (possible part of a car) and bits of rubble. This area appeared to be the site where dumping had taken place.

Towards the end of the dive a typical rock cliff was climbed.

Fauna

Upon arrival at the bottom a number of squat lobsters (Munida quadrispina) and Crangonidae as well as three grey cod (Gadus macrocephalus) were observed. The numbers of decapod crustacea were not as great however as those observed on the previous (No. 597) dive in Tahsis Inlet. Other fauna observed on the bottom included scale worms (Polynoidae) a number of polychaete tubes protruding from the mud, prawns (Pandalus platyceros), various unidentified shrimp. poachers (Agonidae) and eelpouts (Zoarcidae). In the areas where dumped material was concentrated there was a significant reduction in the numbers of epifaunal and infaunal lifeforms.

The fauna found on the cliff climbed at the end of the dive was typical for the area. Included were calcareous tubiculous polychaetes, Rossia pacifica, prawns (Pandalus platyceros), eelpouts (Zoarcidae), pricklebacks (Stichaeidae), poachers (Agonidae), sole (Pleuronectidae), and the solitary ascidian Ascidia peritropa.

Comments

Two patches of heavy concentrations of woodwaste were located. In both of these areas epifauna and infauna had been entirely eliminated. The destruction was however quite localized and it would be of interest to continue investigation of the area to plot the course of recolonization.

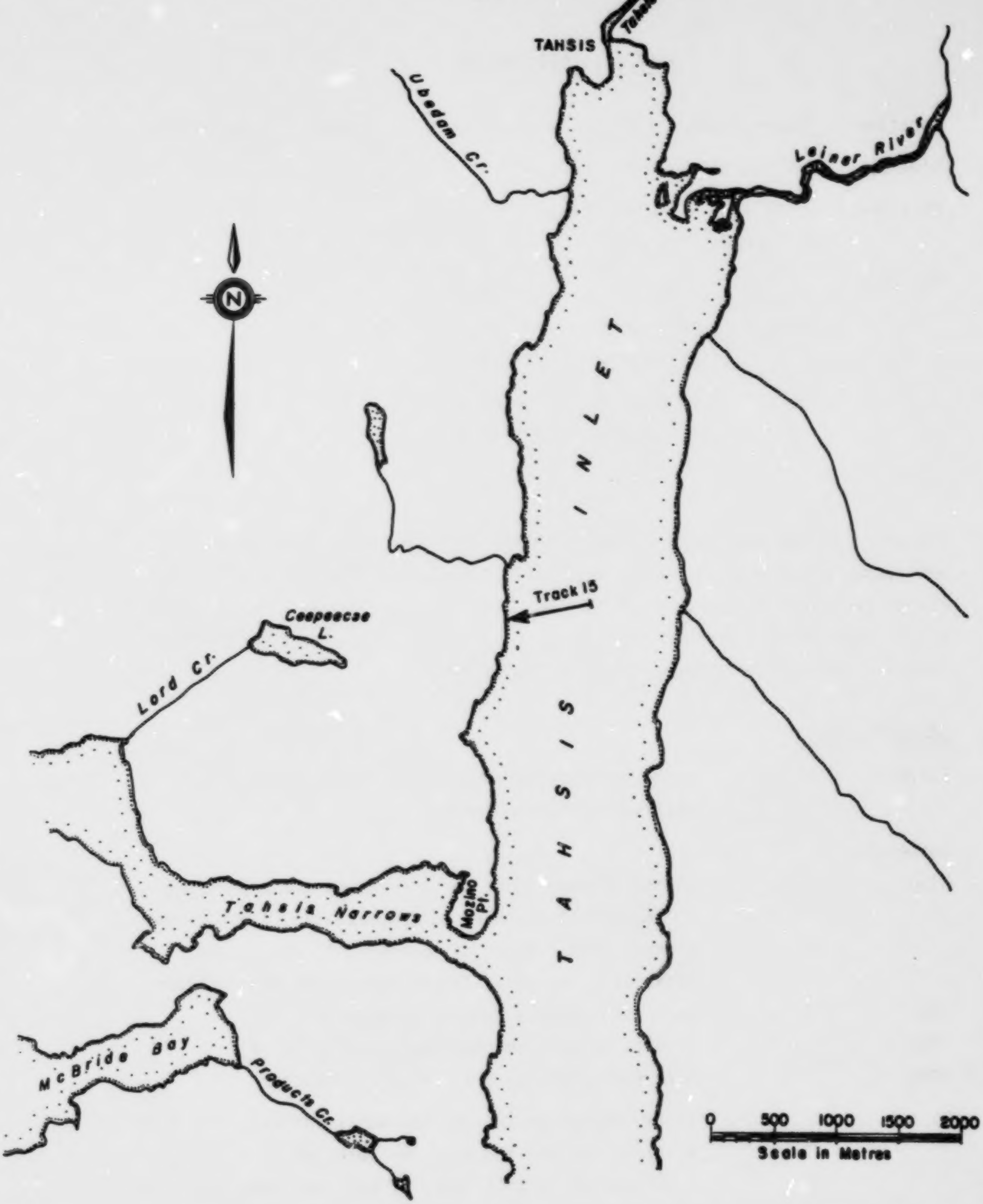
Tahsis R.
TAHSIS
Ubedam Cr.
Leiner River
N
TAHSIS INLET
Track 15
Ceepeecee L.
Lord Cr.
Tahsis Narrows
Mozino Pt.
McBride Bay
Products Cr.
0
500
1000
1500
2000
Scale in Metres

FIG. 24 PISCES DIVE TRACK, TAHSIS INLET (1977).

PISCES IV DIVE RECORD

Location: Stuart Channel (Crofton pulp mill) Date: 12 April 1978

Dive No.: 647 (tracks 1 & 2) (Fig. 25)

Observers: N. Holman, H. Nelson (track 1)
G. Packman (track 2)

Position:

	Start	Finish
track 1	49°53.85'N 123°37.65'W	49°53.55'N 123°38.10'W
track 2	49°54.10'N 123°37.70'W	49°54.00'N 123°38.00'W

Depth: 140m

The start of the dive corresponded with the beginning of a flood tide. It was commenced at a depth of 140 metres (78 fathoms) in Stuart Channel. The Pisces proceeded at a course of 215° mag. towards the Crofton diffuser outfall pipes situated at a depth of 18 metres (south sewer) and 27 metres (north sewer). See attached figure for position of track.

OBSERVATIONS:

Surface	- water murky, fine wood fibres in suspension, few plankters (siphonophores).
Descending	
15m	- clumps of wood fibre in suspension, these persisted to the bottom and were most noticeable, i.e., larger clumps, from a depth of 70 metres to the bottom. Visibility was variable throughout the water column.
50m	- more zooplankters, mostly euphausids
70m	- several pelagic shrimp (Pasiphaea pacifica)
100m	- more euphasids, several pelagic amphipods
Bottom	- at 140 metres depth. Bottom was relatively flat with a slight incline and very few potholes. Substrate was a thin layer of soft mud overlying small rocks and mud. A weak bottom current (1 km/hr to 2 km/hr) was present, coming from a direction of 90° mag. Recordings made on the STD probe were as follows:

- conductivity - 32.093
- temperature - 8.074°C
- depth - 143.15m

- the dissolved oxygen reading on the STD probe fluctuated between 6 and 8.5 ppm.
- there was much indication of burrowing activity however very few large potholes.
- benthos consisted of brittle stars, "sidestrip shrimp" (Pandalopsis dispar) and spirontocarid shrimp, eel pouts, burrowing sea cucumbers, burrowing anemones (Pachycerianthus sp.), and red rockfish.
- the Pisces headed off on a course of 215° magnetic. After approximately 1 hour of travel the bottom had not changed appreciably. Additional benthos observed included "pink" shrimp (Pandalus borealis, identification not definite), a few skate, many tanner crabs, a few Cancer magister, a few ratfish, two prickleback fish, a single dogfish, and a single perch-like fish. The Pisces passed over a depression in the bottom containing 8-10 prawns (P. platyceros); no other prawns were observed on the dive. The depth after 1 hour of travel was 130 metres and the weak bottom current was still present and persisted throughout the dive.

105m

- a white slime appeared in patches on the substrate indicating decomposition of organic material possibly fibre, although fibre deposits were not evident.
- shrimp present in great abundance, most appeared to be juvenile "pink" shrimp (identification not definite).
- the bottom incline had increased slightly.
- trenches along the bottom possibly indicative of commercial trawling activities.

100m

- steep incline encountered with a rock face and associated benthos change, i.e., large anemones (Metridium sp. and an unknown pink species).

90m	- another change in bottom topography to a rocky substrate and an incline of approximately 35°. The clumps of suspended fibre were increasing. Many worm castings observed and small potholes (3-6 cm diameter) approximately 6/square metre.
78m	- return to soft substrate with increasing slime patches and a noticeable decrease in benthos (only a few shrimp present).
60m	- another steep rock face encountered, many Metridium sp., worm castings, and small gastropods present on rock faces. Rock face followed by reduced incline and soft substrate.
50m	- another rock face encountered followed by soft fibrous substrate. The fibre deposits appeared to be old.
40m	- many sole (15-35 cm length) were present on the soft substrate; however, other benthic life had virtually disappeared with the exception of a few shrimp. Large fibre particles were present suspended above the bottom.
35m	- no shrimp present, many sole on what appeared to be old fibre deposits.
25m	- Pisces moving up an incline of approximately 20° over soft fibrous substrate.
17m	- no benthic organisms observed, water became very murky, no surface light was penetrating the water column.
13m	- began ascent at 1700 hours.
Surface	- STD probe recordings - dissolved oxygen - 14 ppm - conductivity - 31.59 - temperature - 9.78°C - depth - 2m - the Pisces surfaced approximately 100 metres north west of the vent tower for the north outfall.

SUMMARY

The dive was characterized by an abundance of shrimp at depths of about 100 metres with a soft mud substrate. In the area between 100 metres depth and 60 metres depth steep rocky slopes were encountered interspersed with areas of reduced incline and soft substrate (step-like configuration). The rock faces were from 3 to 10 metres in height and were inhabited by large anemones and some gastropods.

From 50 metres depth to 25 metres depth the dominant benthic organisms were sole with a gradual decrease in the numbers of shrimp. At these depths the bottom topography was also step-like with the soft substrate between rock slopes becoming more fibrous in nature as the Pisces proceeded shoreward.

From the 25 metre depth until the Pisces surfaced from 13 metres depth, the bottom was inclined about 20° and was characterized by a soft fibrous substrate. No life was observed on the bottom from the 17 metre depth to the completion of the dive.

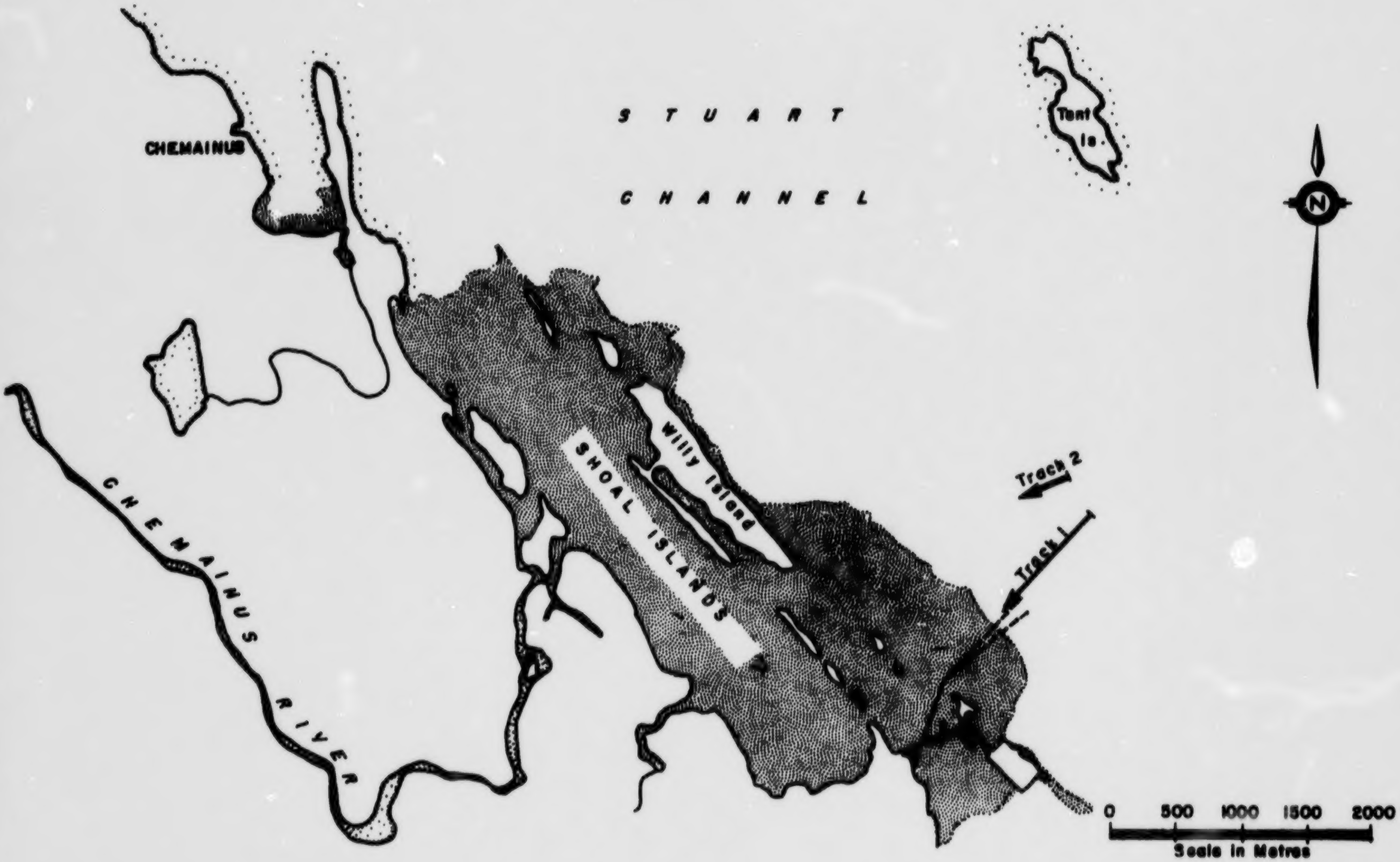
CHEMAINUS
S T U A R T
C H A N N E L
Tent Is.
N
Willy Island
SHOAL ISLANDS
Track 2
Track 1
C H E M A I N U S R I V E R
0 500 1000 1500 2000
Scale in Metres

FIG. 25 PISCES DIVE TRACKS, STUART CHANNEL (CROFTON PULPMILL). 1978.

PISCES IV DIVE RECORD

Location: Northumberland Channel (Harmac diffuser) Date: 14 April 1978

Dive No.: 649 (track 1) (Fig. 26)

Observers: N. Holman, G. Packman

Position:	Start	Finish
	49°08.7'N	49°09.00'N
	123°51.7'W	123°51.45'W

Depth: 109m

Watercolumn

Very little phytoplankton or zooplankton was apparent in the watercolumn. However, a layer of copepods and detritus was observed at a depth of 40-43 metres. At 72 metres amphipods, euphausids and a siphonophore were observed while at 80 metres a relatively dense layer of euphausids was observed. A ctenophore was also observed at 80m. The dissolved oxygen reading on the CTD probe was 8.5 - 8.6 mg/l throughout the descent. The depth at the point of descent was 85m.

Oceanographic Data (as collected with N.I.O. bottles)

Station	Depth	Temperature	Salinity	Dissolved Oxygen	% Saturation
NC-13 (over the Harmac Diffuser)	0	8.93	27.86	8.85	93.59
	2	8.93	28.07	8.70	92.15
	5				
	10	8.65	28.46	8.20	86.50
	25	8.45	28.72	7.85	82.57
	50	8.08	29.30	6.60	69.06
	90	8.15	29.61	5.90	61.98

Station	Depth	Nitrate	Nitrite	Ammonia	Total Phosphate
NC-13	0	0.266	<0.0050	0.0055	0.0670
	2	0.289	<0.0050	0.0080	0.0695
	5	0.289	<0.0050	0.0080	0.0665
	10	0.308	<0.0050	0.0105	0.0698
	25	0.330	<0.0050	0.0130	0.1600
	50	0.355	<0.0050	0.0100	0.0733
	90	0.390	0.0023	0.0050	0.0825

Bottom Characteristics

The bottom throughout the dive was observed to be a soft mud bottom with an occasional rock or log protruding. The substrate did however change markedly in the vicinity of the pipe end. The soft silt had been blown away from that area and woodchips, gravel and non-degradable metal and plastic items were apparent. A thin white film was apparent over the substrate. Further away from the diffuser where silt was present, woodchips appeared to lie under the silty layer.

Bottom Fauna

The bottom fauna in the portion of the dive where the diffuser was approached was fairly uniform, typical of a soft mud bottom. The fauna observed on the track leading up to the pipe included; sea anemones (*Metridium senile*), large snails (*Neptunea* sp.), small sea cucumbers (probably *Chirodota* sp.), crangon, prawns (*Pandalus platyceros*), squat lobsters (*Munida quadrispina*), Dungeness crabs (*Cancer magister*), dogfish (*Squalus acanthias*), ratfish (*Hydrolagos colliei*), whitebarred prickleback (*Poroclinus rothrocki*), unidentified pricklebacks (Stichaeidae), tomcod (*Microgadus proximus*), grey cod (*Gadus macrocephalus*), rockfish (*Sebastes* sp.), lemon sole (*Parophrys vetulus*), unidentified sole (Pleuronectidae) and eelpouts (Zoarcidae). The bottom had holes in it which varied in size and density (from a few to many in a given area) throughout the dive. These holes are indicative of density in the benthic community. Also the numbers of *Chirodota* sp. varied from as few as <1/m^2 to as many as 20 - 30/m^2.

While running down the pipe towards the diffuser the fauna was observed to be similar in nature and composition to that observed while attempting to locate the pipe. There were however a number of epifaunal forms utilizing the pipe both as protective cover and as a substrate. These forms included sea anemones (*Metridium senile*) using the effluent pipe as a substrate. The fauna using the pipe as protective cover included increased members of crangon, prawns (*Pandalus platyceros*), Dungeness crabs (*Cancer magister*) and rockfish (quillback rockfish, *Sebastes maliger*; yelloweye rockfish, *Sebastes ruberimus*).

In the degraded area around the end of the diffuser very little benthic infauna was observed. There were however a number of prawns (*Pandalus platyceros*), a crab (*Cancer productus*) and a large grey cod (*Gadus macrocephalus*).

Pipe and Diffuser

Where the pipe was initially contacted it was observed to be approximately 60 - 90 cm. in diameter and partially sunk into the substrate. Shortly before the diffuser was reached the pipe diameter increased to 1m - 1.3m. A good view of the diffuser itself was not available on this dive.

Summary and Conclusions

The diffuser was not operating at the time of this dive and as a result no discolouration was apparent in the watercolumn and no observations could be made on the behaviour of the effluent at the point of discharge. There appeared to be a degraded area at the end of the diffuser pipe. Material such as woodchips and debris had collected there eliminating the benthic infauna. There was however epibenthic and bathypelagic fauna in this area indicating that water quality had not been permanently impaired.

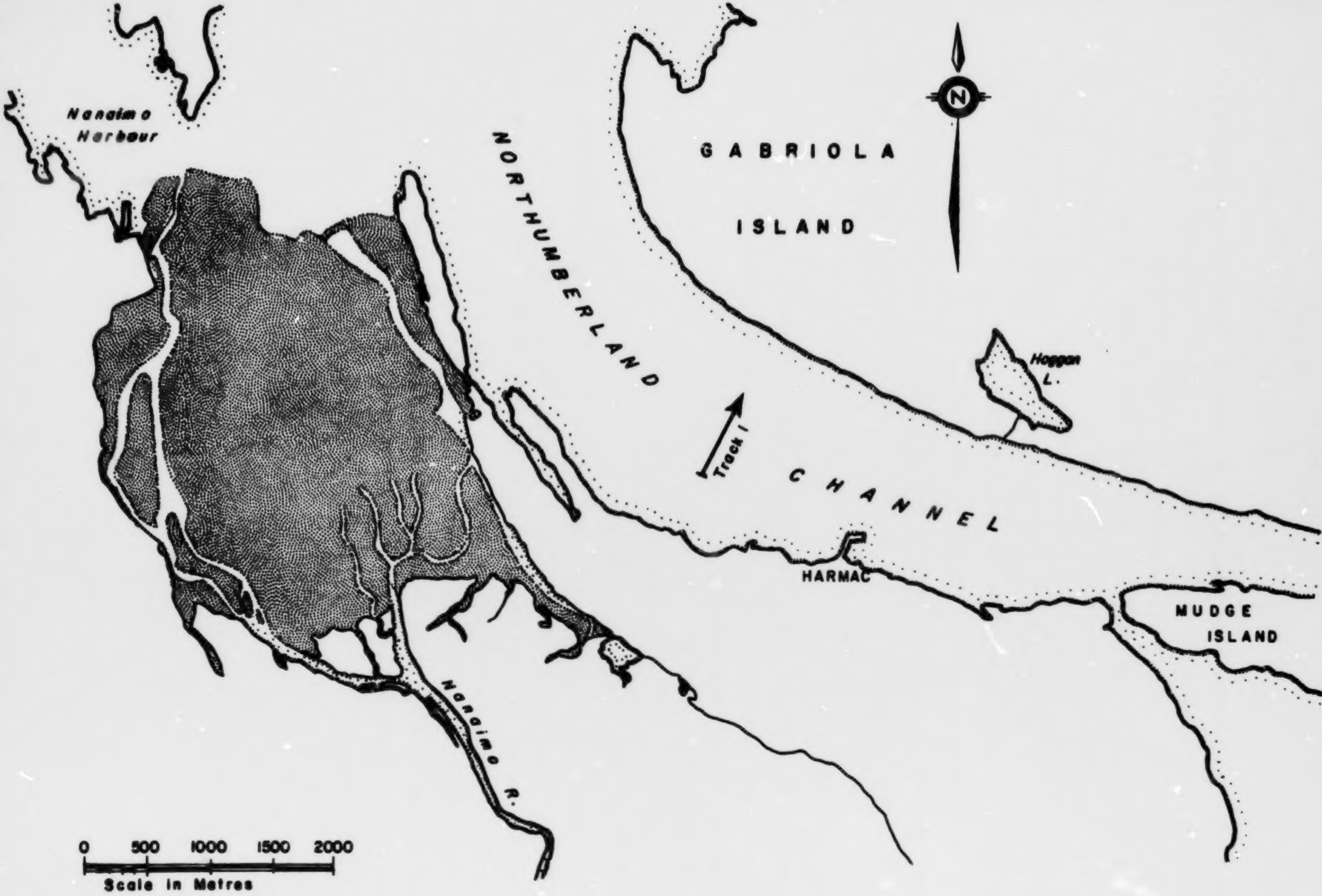
Nanaimo Harbour
GABRIOLA ISLAND
N
NORTHUMBERLAND CHANNEL
Hoggan L.
Track I
HARMAC
MUDGE ISLAND
Nanaimo R.
0
500
1000
1500
2000
Scale in Metres

FIG. 26 PISCES DIVE TRACK, NORTHUMBERLAND CHANNEL (HARMAC) 1978.

PISCES IV DIVE RECORD

Location: Northumberland Channel (Harmac diffuser) Date: 15 April 1978

Dive No.: 651 (track 2) (Fig. 27)

Observers: G. Packman, N. Holman

Position:	Start	Finish
	49°08.84'N	
	123°51.83'W	

Depth: 95m

Watercolumn

On descending through the watercolumn between the surface and 36m small particulates and detritus were noted in the watercolumn as well as a brown colour presumably from the Harmac effluent stream. At 39 metres the brown colour cleared slightly and at 42 metres extended agglomerations of detritus were observed. A Chaetognath was noted at 46 metres while from 64 metres to 70 metres increasing numbers of amphipods were noted. The turbidity increased slightly as the bottom was approached. Generally speaking there was little in the way of phytoplankton and zooplankton in the watercolumn. The depth at the initial point of descent was 94 metres.

Bottom Characteristics

The bottom on the approach to the pipe was a flat mud bottom with an occasional log or rock on the surface. The number of holes from benthic infauna varied over the approach to the pipe but was noted at 2 - 5 holes/metre^2 shortly after the start of the run. Just before encountering the pipe loose clumps of clay were noted.

The bottom characteristics changed dramatically at the end of the diffuser. A thin white coating was noted on the surface of the sediment which could have been either fibre or a bacterial slime or a combination of the two. The bottom was also covered with wood waste debris and bits of non-degradable material. The bottom conditions were surveyed on a course of 340°M directly out from the end of the pipe. On this line the fibre or bacterial slime extended approximately 30 - 40 metres from the pipe end. There was still lots of woody debris apparent at the end of this line.

Bottom Fauna

On the approach to the pipe the fauna observed was typical of a soft mud substrate. The types noted included sea anemones (Metridium senile), Gastropteron pacificum, an octopus, a gastropod (Neptunea sp.) euphasids just above the bottom, prawns (Pandalus platyceros), pink shrimp (Pandalus sp.) crangon, squat lobsters (Munida quadrispina) hermit crabs (Pagurus sp.), Dungeness crabs (Cancer magister), sea cucumbers (Chirodota sp.), a skate (Rajidae), catfish (Hydralogos colliei), grey cod (Gadus macrocephalus), tomcod (Microgadus proximus), eelpouts (Zoarcidae), pricklebacks (Stichaeidae), rockfish (Sebastes sp.) and sole (Pleuronectidae).

The numbers of Chirodota sp. varied from as low as 2 - 5 individuals per square metre to 20 - 30/m^2 but were apparent throughout the dive.

The fauna observed while running along the pipe was similar to that observed on the approach. However in addition to those types lingcod (Ophiodon elongatus) were also observed. Sea anemones (Metridium senile) were noted clinging to the pipe. Prawns (Pandalus platyceros) and pink shrimp (Pandalus sp.) were noted in considerable numbers utilizing the sheltered habitat under the curve of the pipe. Also a number of rockfish (Sebastes sp.) were observed around the pipe.

Little or no benthic infauna was observed in the degraded area at the end of the diffuser. A considerable number of epifaunal and bathypelagic forms were however noted in this area. These forms included polychaetes (Polynoidae), crangon, Dungeness crabs (Cancer magister), dogfish (Squalus acanthias), plainfin midshipman (Porichthys notatus), grey cod (Gadus macrocephalus), and rockfish (Sebastes sp.).

Description of Diffuser

The diffuser appeared to be approximately one metre in height with the ports located on the top. The end was open and there was a small, upturned lip on the bottom, presumably to deflect debris up and clear of the end. Some reference numbers were noted on the pipe and photographed for future reference. A small pipe was noted running along the top of the effluent pipe.

It was difficult to observe the effluent coming out of the pipe as it came out with a considerable pressure, catching Pisces and carrying the boat up with it. The effluent was however observed to stream straight up from the diffuser ports.

Summary and Conclusions

The observed area of benthic disruption appeared limited in area extending 30 - 40m from the open end of the diffuser. In this area, directly adjacent to the pipe the silt had been blown away and some woodwaste, gravel and non-degradable material was present. Further out from the pipe the substrate was coated with a layer of bacterial slime or fibre or a combination of both, indicative of an adverse affect stemming from the release of suspended solids from the pulpmill. The disruption at the present time did not appear to be too extensive. However this should be monitored over time by means of a sediment coring program conducted by the mill to avoid the development of a serious problem.

On this dive the effluent was visible in the watercolumn.

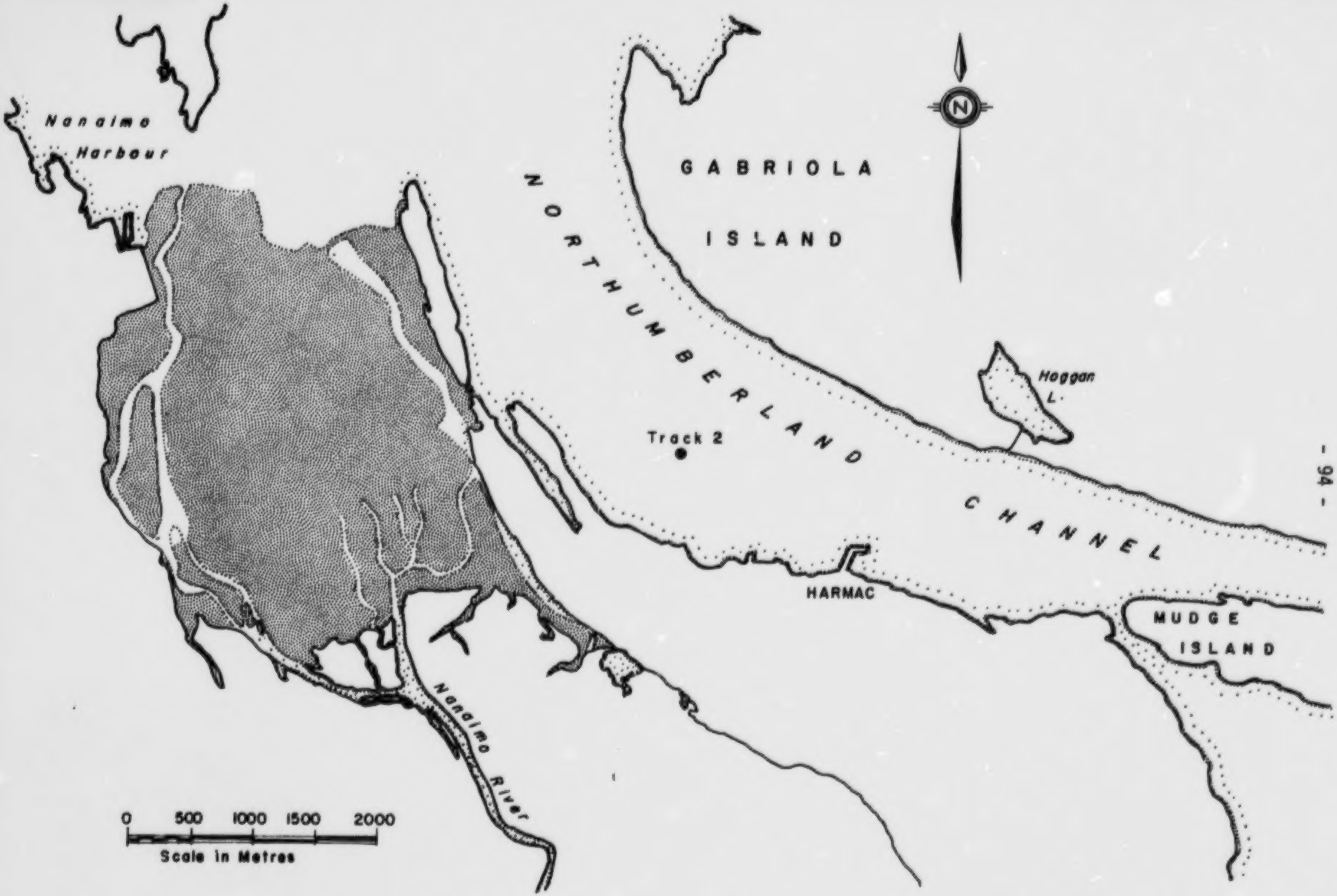
Nanaimo Harbour
GABRIOLA ISLAND
NORTHUMBERLAND CHANNEL
N
Hoggan I.
Track 2
HARMAC
MUDGE ISLAND
Nanaimo River
0
500
1000
1500
2000
Scale in Metres

FIG. 27 PISCES DIVE TRACK, NORTHUMBERLAND CHANNEL (HARMAC). 1978.

PISCES IV DIVE RECORD

Location: Powell River, Malaspina Strait (proposed pulp mill diffuser location) Date: 30 November 1978

Dive No.: 719 (Track 1) (Fig. 28)

Observers: R. Hoos, H. Nelson

Position:	Start	Finish
	49°52.05'N	49°52.20'N
	124°34.60'W	124°33.80'W

Depth: 100m

The dive commenced in 100 metres of water approximately 200 metres seaward of the estimated termination point for a diffuser proposed for the Powell River pulp mill. The diffuser and pipe are to extend approximately 800 metres from shore with the diffuser portion constituting about 330 metres at the end. The downstream end of the diffuser will be at about 72m depth and the upstream end at about 55m depth. Upon reaching the bottom the Pisces proceeded on a course intended to cover the area into which the diffuser would discharge. As shown on the Figure the course varied slightly from the intended track, however, bottom characteristics should not be significantly different.

OBSERVATIONS:

Surface	- water clear, few plankton observed.
	Descending
20m	- visibility good, surface light, one pelagic polychaete observed, very little suspended material.
30m	- surface light was still evident.
40m	- loss of surface light.
45m	- many pelagic amphipods (white colouration) observed from this depth to the bottom.
75m	- school of herring, 5 - 10 centimetres in length observed.

Bottom

- at 100 metres
- bottom substrate a fine grey-brown sediment underlying a thin layer of wood particles i.e. not a reducing substrate. Small craters about 5 cms in diameter and larger depressions about 30 cms in diameter
- Bottom visibility 5 to 7 metres and no noticeable current was present
- benthos consisted of small shrimp with white legs (approximately 2 or 3 per square metre), eel pouts (*Lycodes* sp.), flat fish, pelagic polychaetes and amphipods, and dungeness crabs (*Cancer magister*).
- moved towards shore at a bearing of approximately 060° magnetic up a slight incline. More wood debris encountered, a few large boulders (50 to 100 cms in diameter), a few large pieces of wood debris and logs. Several greenstriped rockfish (*Sebastes elongatus*) and orange anemones (*Metridium senile*) associated with boulders and large wood debris.

87m - Course change to 040° magnetic. Continued toward shore up a slight incline, substrate became more fibrous in nature and patches of white bacterial slime began to appear. Water became murky briefly. Benthos remained unchanged with the addition of squat lobsters (*Munida quadrispina*) and a few prawns (*Pandalus platyceros*). The numbers of small shrimp increased to 10 to 15 per square metre. Another school of small herring containing several hundred individuals was observed.

84m - encountered several pieces of large wood debris and a few boulders. Benthos associated with this area included organisms mentioned previously and also rat fish (*Hydrolagus colliei*), lingcod (*Ophiodon elongatus*), quillback rockfish (*Sebastes maliger*) and *Neptunea* sp. Another school of herring was observed (or possibly the same school reported earlier). Pieces of rusted pipe and stainless steel wire were observed.

75m - patches of white bacterial slime were more prevalent

- substrate more fibrous in nature with very fine fibres loosely compacted. Less shrimp observed than previously.

72m - observed a large skate (*Raja* sp.)

70m - The surface tender boat estimated our position to be approximately 3/4 of the way along the intended track and approximately 500 metres from shore.

65m - natural substrate in this area appeared to be gravel which had been covered by a fine fibre mat 10 to 30 cms in thickness; wherever a boulder or log had been deposited the fine fibre was displaced beneath the object thereby exposing the gravelly substrate. Many small lingcod (1 to 2 kgs) were noted in the area.

58m - 1 sea cucumber (*Parastichopus* sp.)

- more rusted pipe and wire observed

51m - water became murky again. The small shrimp, present since the beginning of the dive, have disappeared.
CTD Probe recordings - D.O. 5.7 Mg/l
Temp. 9.2°C

- few small squid observed and several flatfish
- patches of white stringy material (bacterial growth?)

43m - (12:30 Hours); patches of bacterial slime increased

36m - visibility improved, wood debris becoming coarser and appears to be of more recent origin.

30m - began moving up steep incline, fibre became progressively more coarse. Visibility increased to 10 to 15 metres with surface light. Many small pieces of white paper were lying on the fibre mat, presumably from the newsprint operation.

10m - bottom levelled off and Pisces began ascent.

Surfaced

- 12:40 hours, tender boat estimated the Pisces surfaced approximately 100 metres from boom sticks at the mouth of the tailrace.

Summary

At the beginning of the dive the bottom substrate was characterized by soft sediment (mud) underlying a thin layer of wood particles. It did not appear to be a reducing sediment. As the Pisces moved shoreward the natural substrate appeared to become gravelly (65m) however it was covered by a progressively thicker layer of fine fibrous wood debris. As the shallower depths were approached (35m) the wood debris became coarser in nature and seemed to be more recently deposited. The only steep incline was encountered at 30m and appeared to be composed of fibrous wood debris. The incline continued to a depth of 10m when the bottom levelled off.

Benthos encountered during the dive were predominately small shrimp, demersal and pelagic fish. Above the depth of 50m no shrimp were observed and the dominant fish were demersal flounders or sole.

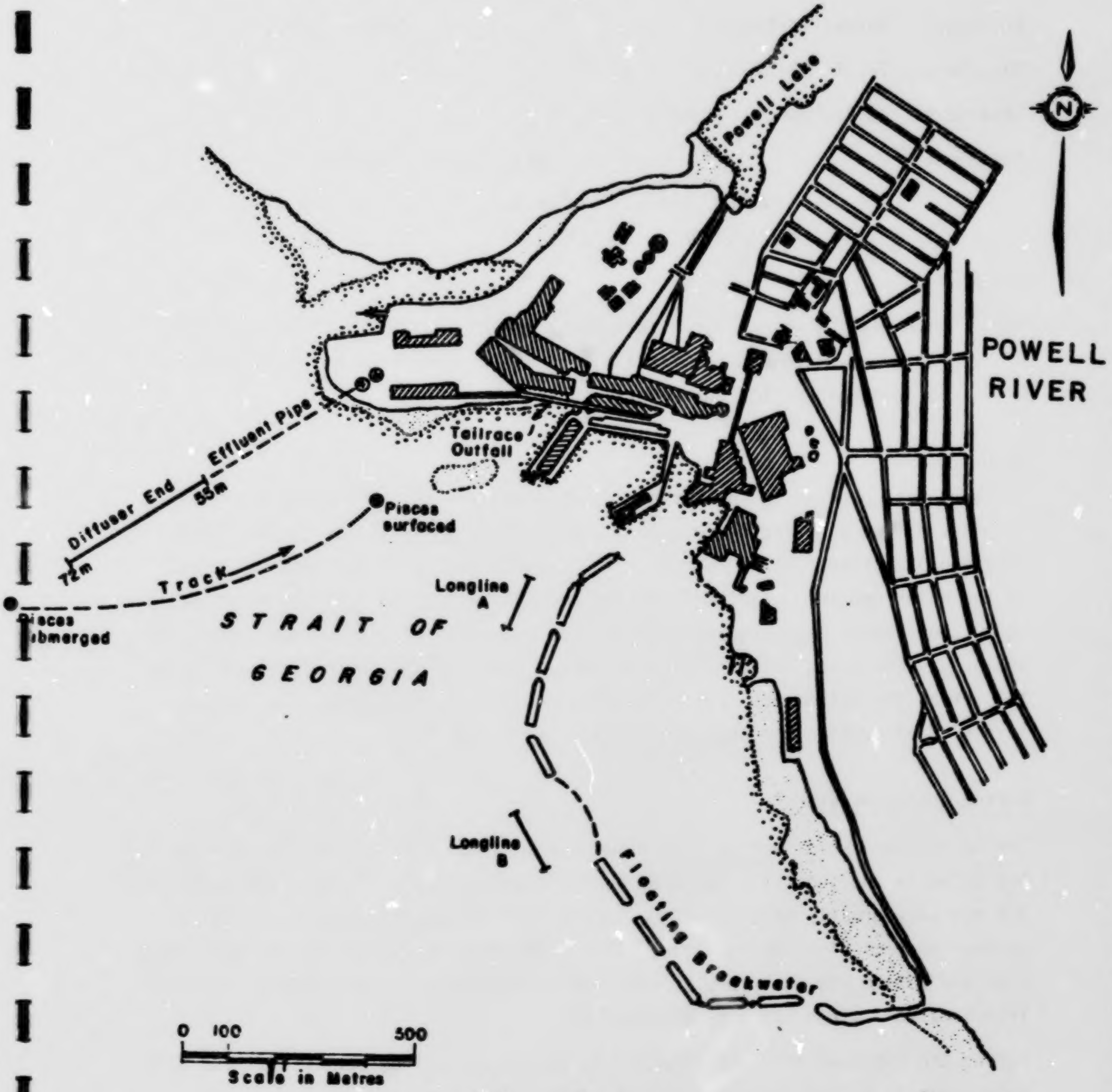
Powell Lake
N
POWELL RIVER
Effluent Pipe
Tailrace Outfall
Diffuser End
55m
72m
Pisces surfaced
Track
isces
ubmerged
Longline A
STRAIT OF GEORGIA
Longline B
Floating Breakwater
0 100 500
Scale in Metres

FIG. 28 PISCES DIVE TRACK, POWELL RIVER (1978).

PISCES IV DIVE RECORD

Location: Harmac (diffuser) Date: 10 May 1979

Dive No.: 761 & 762 (Fig. 29)

Observers: G. Packman, D. Goyette

Position:	Start	Turn	Finish
	48°08.75'N	48°08.82'N	48°08.97'N
	123°51.98'W	123°51.47'W	123°51.45'W

Depth:

Note: Two dives were conducted to inspect the Harmac diffuser due to problems with the Pisces on the first dive. The reports from both dives have been combined into one report.

Water Column

Effluent was observed in the surface water down to a depth of 10-15 metres at both the dive and surfacing locations. At approximately 15 metres the visibility became quite clear. At 25 metres strings of detrital material became apparent in the water and the occasional pelagic amphipod was noted. At the 40-45 metre depth zooplankton began to appear with some ctenophores, scyphozoans, amphipods and euphausids being noted. The zooplankton and detritus concentrations became thicker as the bottom was approached at approximately 80 metres. No further layers of effluent other than the surface layer were noted.

Bottom Characteristics

The bottom on descent during both dives was soft mud without many large holes. The holes in the substrate numbered approximately $1\text{-}2/m^2$. These characteristics did not vary greatly throughout the approach to the outfall pipe. Initially however pockets of white bacterial slime were noted in depressions in the bottom. Also the bottom was disturbed in one area where construction rubble or material from Nanaimo's mines had been disposed of.

During the run down the outfall pipe the bottom was predominantly soft mud with approximately 1 large hole per square metre. Silt was noted to have built up around the lower 1/3 of the pipe. Many crab tracks in the soft sediment were noted running parallel to the pipe. No fibre was apparent on the bottom along the pipe however some bacterial slime was noted along the base. One log was observed lying beside the pipe.

Soft mud remained the predominant substrate at the proximal end of the diffuser. Below the first port of the diffuser some scouring was apparent. The sediment was slightly black indicating that some wood waste must have been deposited and was undergoing reduction. On the eastern side of the diffuser some scouring had occurred. Wood wastes were present in the sediment in this area but not as much as on the western side of the diffuser. As the end of the diffuser was approached more wood debris became apparent.

At the open end of the diffuser scouring was apparent while a significant quantity of wood splinters and chips had been deposited. A course was run directly out from the diffuser end in order to determine whether or not fibre was accumulating and the extent of any accumulation. Extending to a distance of approximately 20 metres from the diffuser end the bottom was composed mainly of splinters, knots and other debris. At about 20 metres from the diffuser end more sediment became mixed in with the wood wastes giving the substrate an appearance similar to that noted in most of the Point Grey ocean disposal site. This course was continued for approximately 60 metres from the outfall where some wood wastes were still noted mixed in with the natural sediments.

A course was also run west from the diffuser. On this course splinters of wood and debris were noted mixed in with fine sediments, extending for a distance of approximately 20 metres. The sediments and wood wastes did not appear to be reduced.

An easterly course was run from the end of the diffuser to delineate the extent of deposition in that direction. The characteristics of the sediment remained the same as on the other two transects with the accumulation of wood debris extending approximately 40 metres.

No real signs of fibre were apparent anywhere, however wood chips, splinters and debris were quite prevalent.

Fauna

The fauna noted during the approach to the outfall pipe was similar to that noted on previous Pisces dives in the area and typical for a soft mud bottom.

The predominant faunal forms included *Chirodota* sp burrowing in the substrate, small shrimp and crangon, eelpouts (Zoarcidae) and pricklebacks (Stichaeidae). During the run down the pipe sea anemones (*Metridium* sp.) were noted on the pipe, as well as squat lobsters (*Munida quadrispina*). Dungeness crabs (*Cancer magister*) and prawns (*Pandalus platyceros*) were noted seeking cover along the bottom of the pipe. In the vicinity of the diffuser some fish and crustaceans were noted. Quite a few squat lobsters (*Munida quadrispina*) were noted amongst the wood wastes near the diffuser end. Also 2 ratfish (*Hydrolagus colliei*), a rockfish (*Sebastes* sp.) and 2 lingcod were noted in close proximity to the effluent stream.

The discharge appeared to be exerting a definite impact upon the benthic receiving environment in the form of wood waste deposition. Wood wastes appeared to have covered the benthic infaunal community. Also eelpouts (Zoarcidae) and pricklebacks (Stichaeidae) were not present in the zone of influence of the diffuser. Squat lobsters (*Munida quadrispina*), ratfish (*Hydrolagus colliei*) and lingcod (*Ophiodon elongatus*) were noted in the immediate vicinity of the discharge.

Conclusions

The bottom observed on the approach to the pipe was a soft mud bottom as noted on previous dives. An accumulation of wood wastes in the form of knots, splinters and industrial debris was noted in the vicinity of the diffuser end. No accumulation of fibre, as such, was noted on this dive. Pisces dives should be continued in the future to monitor the diffuser impact.

Track 1

Faunal Form	Abundance
Metridium sp.	- 4 noted during approach to pipe - many noted on top of pipe.
Rossia sp.	- 1 noted.
Chirodota sp.	- noted occasionally during first portion of dive along pipe approximately 20/m^2 were noted.
Pycnopodia sp.	- 1 noted
Munida quadrispina	- some on rocky rise - lots adjacent to airpipe along top of outfall pipe
Pandalus platyceros	- approximately 15 noted on approach to pipe - quite a few noted along pipe using pipe for cover
Small Pink Shrimp (unidentified)	- noted occasionally on bottom
Crangon sp.	- noted occasionally during approach and along pipe
Cancer magister	- noted occasionally during approach to pipe. - 1 noted approximately every 10m along pipe.
Pagurus sp.	- 1 noted
Hydrolagus colliei	- 5 noted - occasionally quite a few juveniles around boat
Porichthys notatus	- 1 noted
Gadus macrocephalus	- 2 noted
Merluccius productus	- school noted upon initial arrival on bottom

Track 1 (continued)

Faunal Form	Abundance
Zoarcidae	- 6 noted
Stichaeidae	- 9 noted
Sebastes maliger	- 4 noted
Sebastes sp.	- 5 noted
Ophiodon elongatus	- 4 noted - two near effluent
Pleuronectidae	- 12 noted

Track 2

Faunal Forms	Abundance
Metridium	- a few noted on diffuser
Octopus sp.	- 1 noted near diffuser
Chirodota sp.	- quite a few noted in sediment as woodwastes thinned
Pandalus platyceros	- 3 noted under diffuser - 2 noted away from diffuser
Small Unidentified Shrimp	- noted occasionally
Munida quadrispina	- quite a few noted amongst woodwastes
Tanner crab	- 3 noted approximately 20m from diffuser
Hydrolagus colliei	- approximately 7 noted in vicinity of outfall, 2 right under effluent stream
Sebastes maliger	- 2 noted
Ophiodon elongatus	- 5 noted
Pleuronectidae	- 3 noted

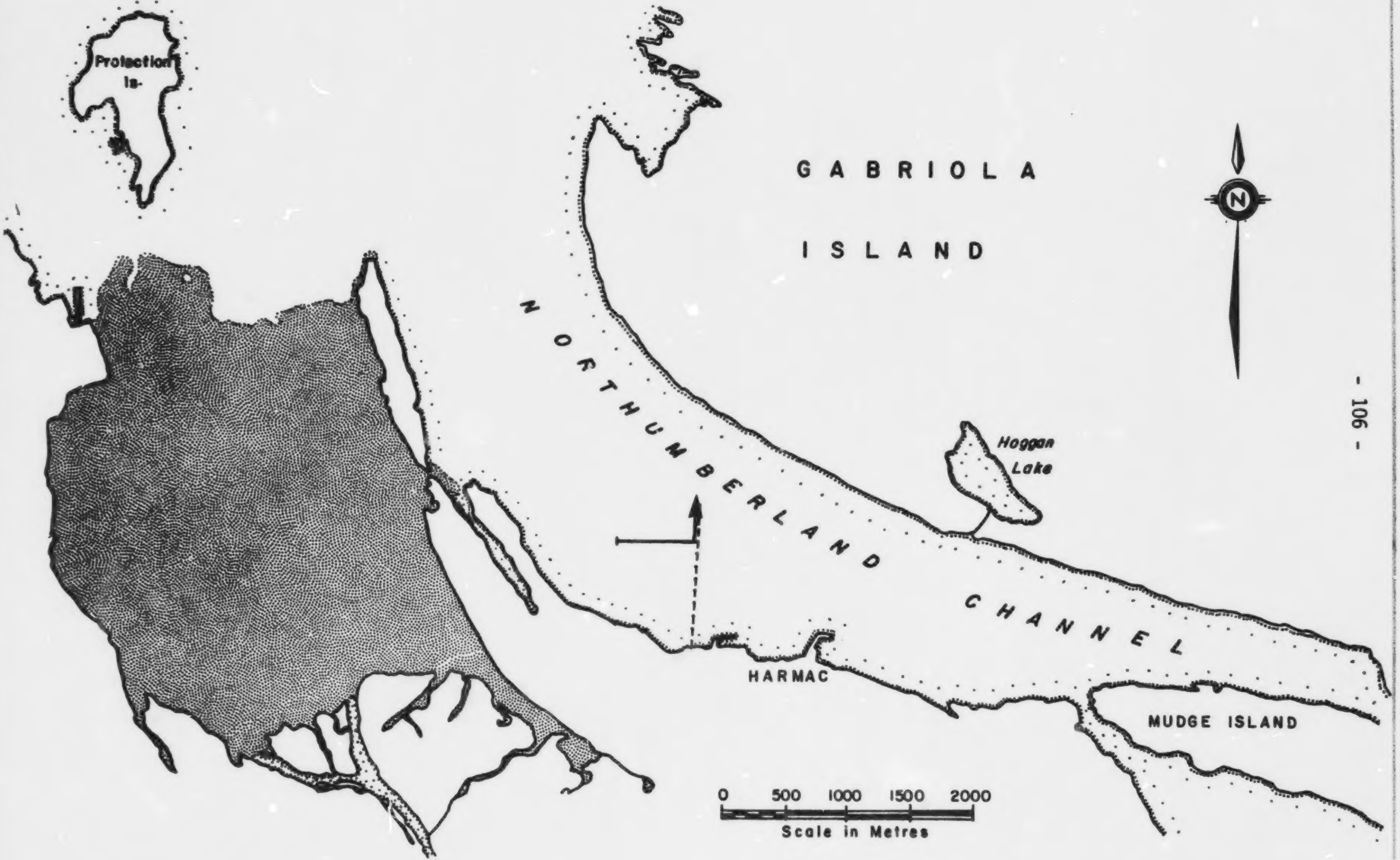
Protection Is.
GABRIOLA ISLAND
N
NORTHUMBERLAND CHANNEL
Hoggan Lake
HARMAC
MUDGE ISLAND
0 500 1000 1500 2000
Scale in Metres

FIG. 29 PISCES DIVE TRACK(S), NORTHUMBERLAND CHANNEL (HARMAC) 1979.

PISCES DIVE RECORD

Location: Woodfibre Date: 1 May 1979

Dive No.: 764 (track 1) (Fig. 30)

Observers: D. Goyette, H. Nelson

Position:	Start	Turn	Turn	Turn	Finish
	49°39.60'N	49°39.83'N	49°39.92'N	49°39.57'N	49°39.18'N
	123°14.80'W	123°14.89'W	123°14.95'W	123°15.04'W	123°14.61'W

Depth: 250m

Note: No report available.

PISCES IV DIVE RECORD

Location: Woodfibre

Date: 11 May 1979

Dive No.: 764 (track 2) (Fig. 30)

Observers: D. Goyette, H. Nelson

Position:	Start	Finish
	49°39.69'N	49°40.05'N
	123°15.24'W	123°14.63'W

Depth:

Note: No report available.

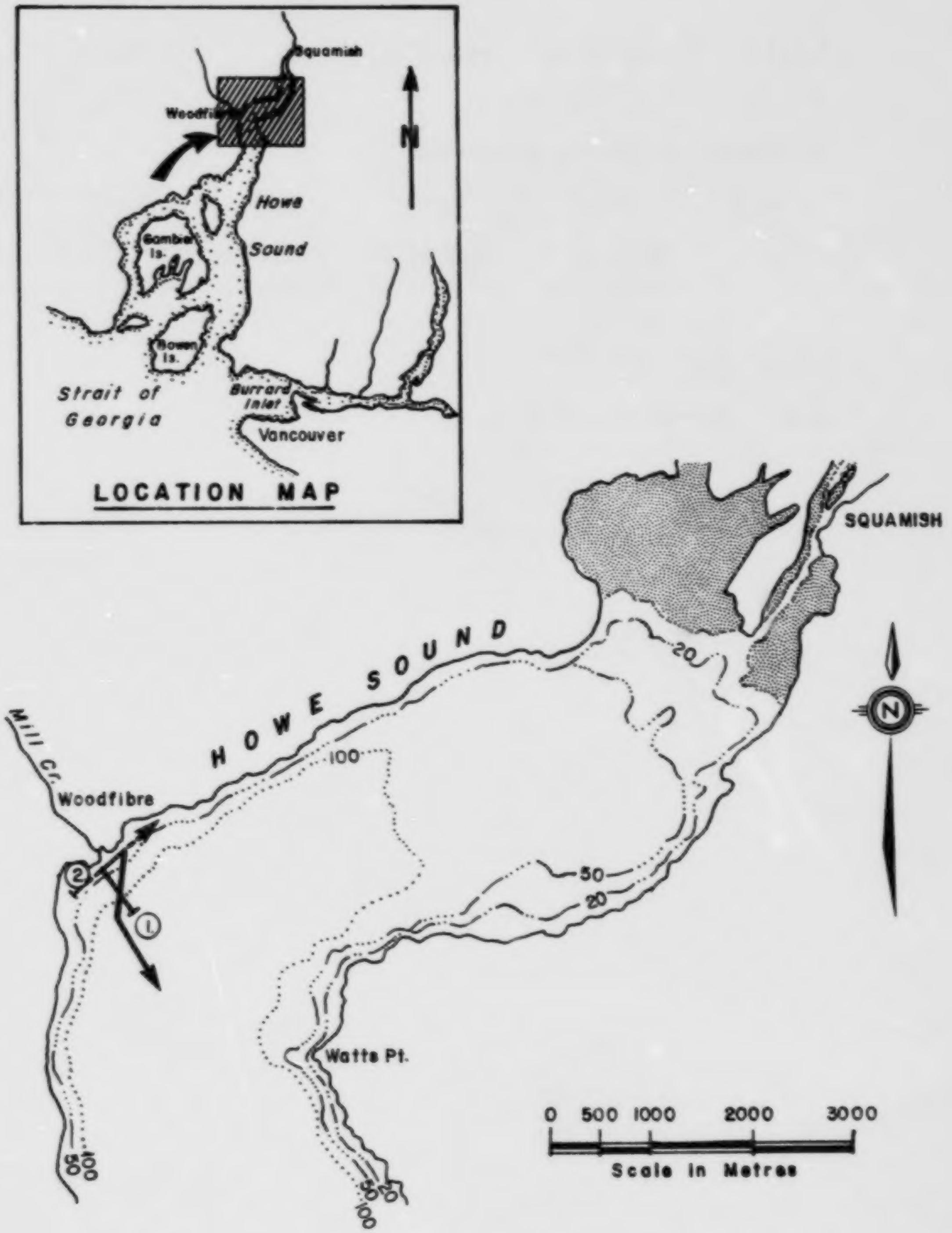
Squamish
Woodfibre
N
Howe
Sound
Gambier Is.
Bowen Is.
Strait of Georgia
Burrard Inlet
Vancouver
LOCATION MAP
SQUAMISH
HOWE SOUND
Mill Cr.
Woodfibre
100
20
50
20
②
①
Watts Pt.
50
100
0 500 1000 2000 3000
Scale in Metres
N

FIG. 30 PISCES DIVE TRACKS, WOODFIBRE (1979).

PISCES IV DIVE RECORD

Location: Powell River (pulp mill) Date: 11 March 1980

Dive No.: 827 (Fig. 31)

Observers: H. Nelson, Mr. Beaton

Position:	Start	Turn	Turn	Turn	Finish
	49°52.29'N	49°52.21'N	49°52.07'N	49°52.12'N	49°52.23'N
	124°34.29'W	124°34.12'W	124°34.40'W	124°34.35'W	124°34.08'W

Depth: 75m

Note: No report available.

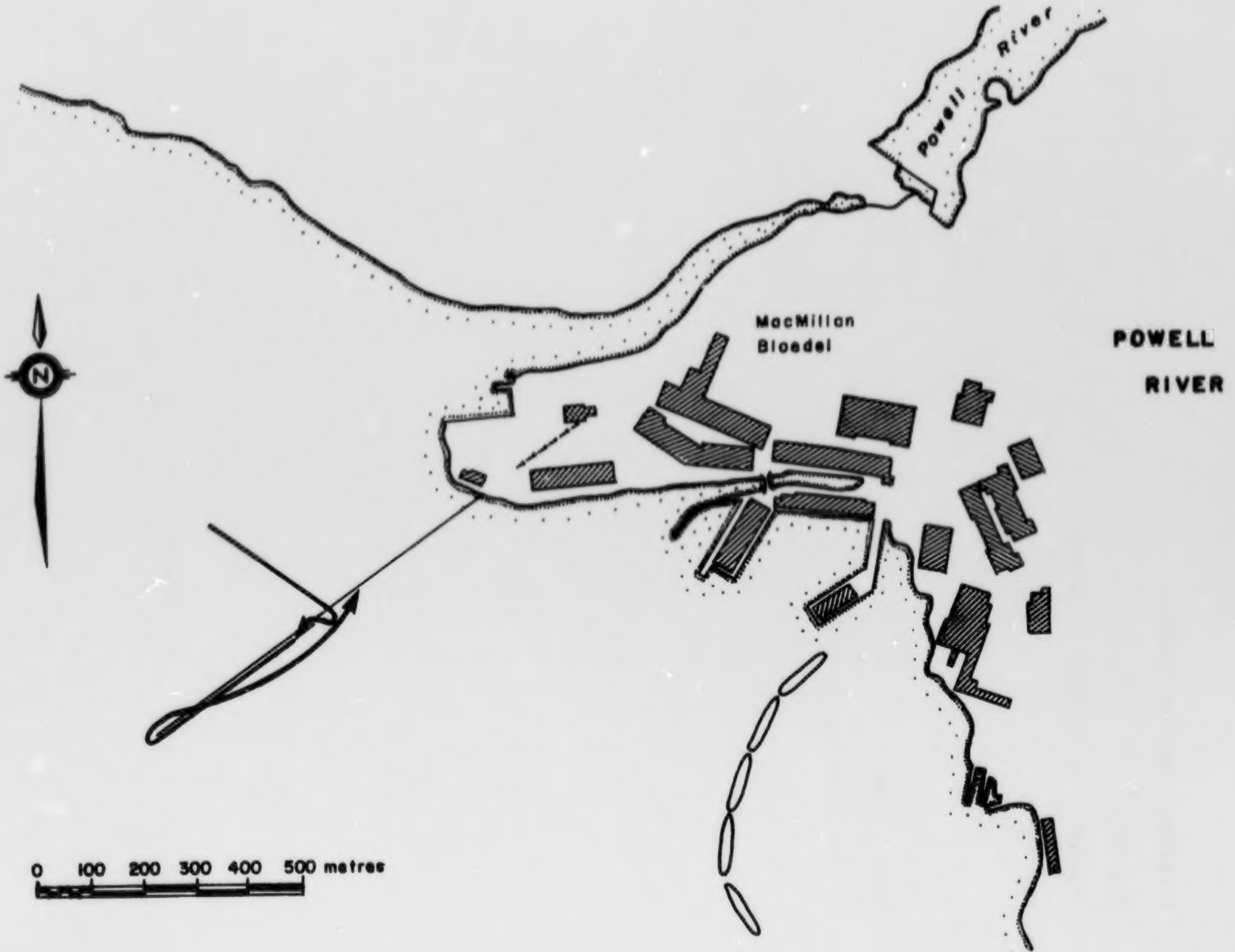
Powell River
MacMillan Bloedel
POWELL RIVER
N
0 100 200 300 400 500 metres

FIG. 31 PISCES DIVE TRACK, POWELL RIVER PULPMILL (1980).

PISCES IV DIVE RECORD

Location: Nanaimo (Harmac)

Date: 18 March 1980

Dive No.: 834 (Fig. 32)

Observers: G. Packman, N. Holman

Position:	Start	Turn	Finish
	49°08.53'N	49°08.53'N	49°08.98'N
	123°51.18'W	123°51.46'W	123°51.43'W

Depth: 100m

Note: No report available.

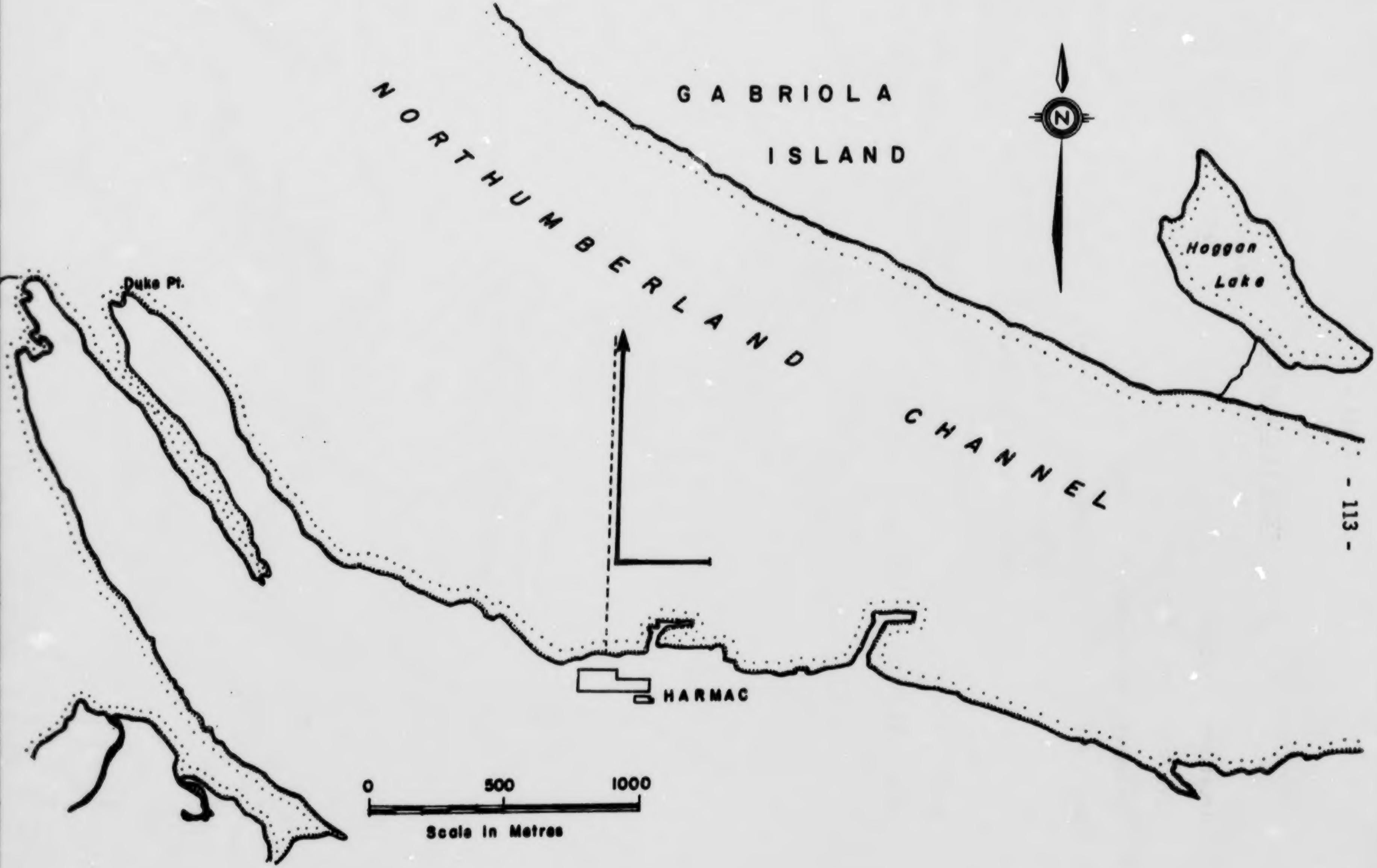
GABRIOLA ISLAND
NORTHUMBERLAND CHANNEL
Hoggan Lake
Duke Pt.
HARMAC
0
500
1000
Scale in Metres

FIG. 32 PISCES DIVE TRACK, NANAIMO (HARMAC) 1980.

PISCES IV DIVE RECORD

Location:	Crofton	**Date:**	19 March 1980

Dive No.: 835 (Fig. 33)

Observers: G. Packman, N. Holman

Position:	Start	Finish
	48°54.06'N	48°53.61'N
	123°37.38'W	123°37.98'W

Depth: 170m

Note: No report available.

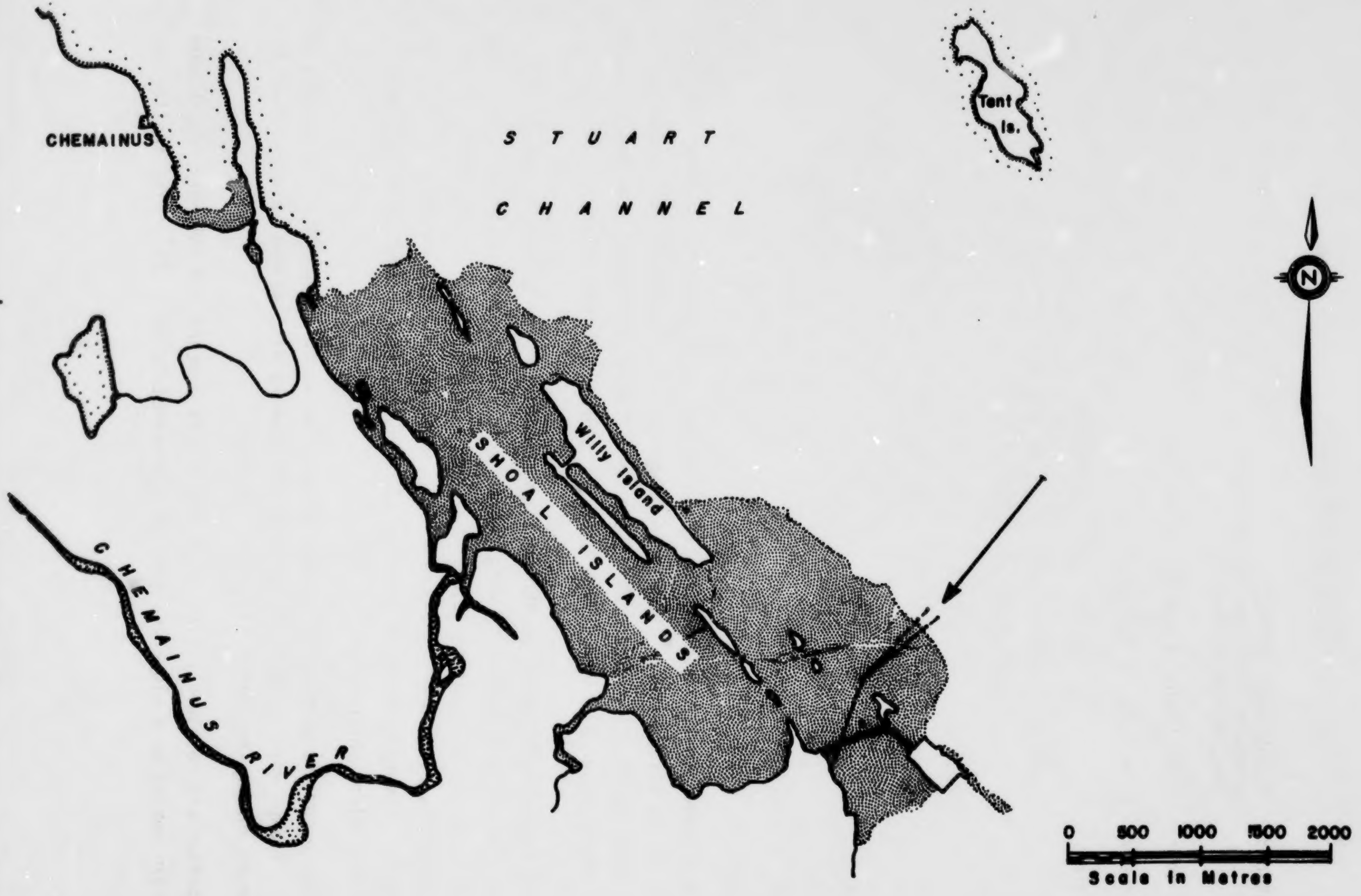
CHEMAINUS
S T U A R T
C H A N N E L
Tent Is.
N
Willy Island
SHOAL ISLANDS
CHEMAINUS RIVER
0
500
1000
1500
2000
Scale in Metres

FIG. 33 PISCES DIVE TRACK, CROFTON PULPMILL (1980).

PISCES IV DIVE RECORD

Location: Thornbrough Channel (proposed diffuser location off Port Mellon Pulp Mill)

Date: 19 March 1981

Dive No.: 1012 (track 1 and 2) (Fig. 34)

Observers: H. Nelson, D. DeMill

Position:

	Start	Finish
Track 1	49°31.17'N 123°28.66'W	49°31.3'N 123°28.8'W
Track 2	49°31.21'N 123°28.60'W	49°31.3'N 123°28.8'W

Depth:

Track 1

Summary

The dive began in 197 metres of water approximately 600 metres southeast of the mouth of the Rainy River. The Pisces proceeded on a course of 324° which would take it along the line proposed for the new effluent diffuser. The new diffuser will extend about 300 metres from shore to a depth of approximately 120 metres.

At the beginning of the dive the bottom was comprised of a thin layer of silt, brown sediment and pockets of wood debris overlying a sand substrate. Rocks and boulders appeared in patches along the course of the dive. The majority of the rocks observed were 10 to 30 cm. in diameter with a few to about 80 cm. in diameter. Several pieces of scrap metal, plastic, rubber and old planks were scattered along the bottom.

Various organisms were observed during the dive as noted in the attached species list. Prawns were present in the greatest numbers with several hundred juveniles observed during the latter stages of the dive.

The bottom was relatively flat until the Pisces reached the 155 metre depth when it began moving up a slope inclined at approximately 20° - 25°. The incline increased gradually as Pisces proceeded towards shore with a 35° - 45° angle at 70 metres depth, a 45° angle at 40 metres, and a 60° angle at 13 metres depth. There was no evidence of sloughing, however a small trough was encountered at the 100 metres depth.

OBSERVATIONS:

Bottom	- 197 metres, good visibility (approx. 6m), no current. - soft brown sediment and patches of wood debris overlying sand substrate. - little indication of burrowing activity. - proceeding towards shore on a course of 324° (mag.).
175m	- patches of rocks and boulders, scrap metal.
155m	- incline of approximately 20° - 25°, bottom relatively flat with rocks and boulders protruding.
135m	- area traversed with no rocks visible, approximately 20 metres.
100m	- trough observed approximately 6 metres across with sides 1 and 2 metres high.
90m	- continuing up incline, industrial debris decreased slightly otherwise bottom unchanged.
70m	- incline of slope increased to 35° - 45°.
53m	- the numbers of rocks and boulders have decreased.
40m	- slope increased to 45° incline, still fewer rocks and boulders than earlier in dive.
30m	- still fewer rocks and boulders.
21m	- incline of slope increasing, more wood debris encountered extending to at least 10 centimetres in depth. - patches of white bacterial slime observed.
13m	- very steep slope (60°) of wood debris with black (reducing) sediments below the surface layer. - dive terminated.

Track 2

Summary

The dive began in 158 metres of water approximately 450 metres from shore. The Pisces proceeded toward shore on a course of 298° (mag.) following a proposed diffuser line presented as an alternate to that followed in Track 1. At the beginning of the dive the bottom consisted of fine brown sediment, wood debris, scrap metal, leaves and small rocks overlying sand. The Pisces proceeded up a slope which rose off to the right of the Track and was inclined approximately 15°. The angle of the slope increased throughout the dive ie. 30° at 136 metres, 35° at 86 metres, to a maximum of 55° to 60° at the end of the dive at 17 metres.

As with Track 1 the bottom was relatively smooth with rocks and boulders occurring in patches. There appeared to be more small rocks and gravel on Track 2 and a fewer number of the larger boulders. Marine life was the same as the previous track with a predominance of prawns.

At a depth of 70 metres the amount of wood debris on the bottom increased with a subsequent increase in the number of juvenile prawns. At 36 metres depth an area of sloughing was observed where the sloughed material was mainly wood waste ie. wood chips and bark fragments. From this depth to the end of the dive at 17 metres the slope was very steep and appeared to be comprised of wood wastes.

OBSERVATIONS:

Bottom	- 158m, good visibility, no discernable current.
136m	- slope increased to 30° incline, no large boulders, no evidence of sloughing.
124m	- pockets of wood debris with increased numbers of squat lobsters.
114m	- very few rocks in this area, some wood debris and scrap metal.
97m	- bottom substrate changed to small rocks and gravel.
86m	- slope incline increased to 35°.
70m	- more wood debris encountered and an increase in numbers of juvenile prawns.

55m - size of rocks increased.

36m - evidence of sloughing from a slope of predominately wood waste.

28m - steep slope of wood debris.

23m - slope very steep (55° to 60°), wood wastes and patches of white bacterial slime.

17m - end of dive on steep slope of wood wastes.

Pisces IV Dive 1021 - Species List

dogfish - *Squalus acantheas*
ratfish - *Hydrolagus colliei*
pollock - *Theragra chalcogramma*
hake - *Merluccius productus*
midshipman - *Porichthys notatus*
sidestrip shrimp - *Pandalopsis dispar*
Pelagic shrimp - *Paciphaea pacifica*
Pink shrimp - *Pandalus borealis*
burrowing anemone - *Pachycerianthus* sp.
anemone - *Metridium senile*
squat lobster - *Munida quadrispina*
Dungeness crab - *Cancer magister*
prawn - *Pandalus platyceros*
octopus - *Octopus* sp.
snail - *Colus* sp.

- other organisms observed but not identified to species included: rockfish, anemones, eel pouts, small shrimp, plankters.

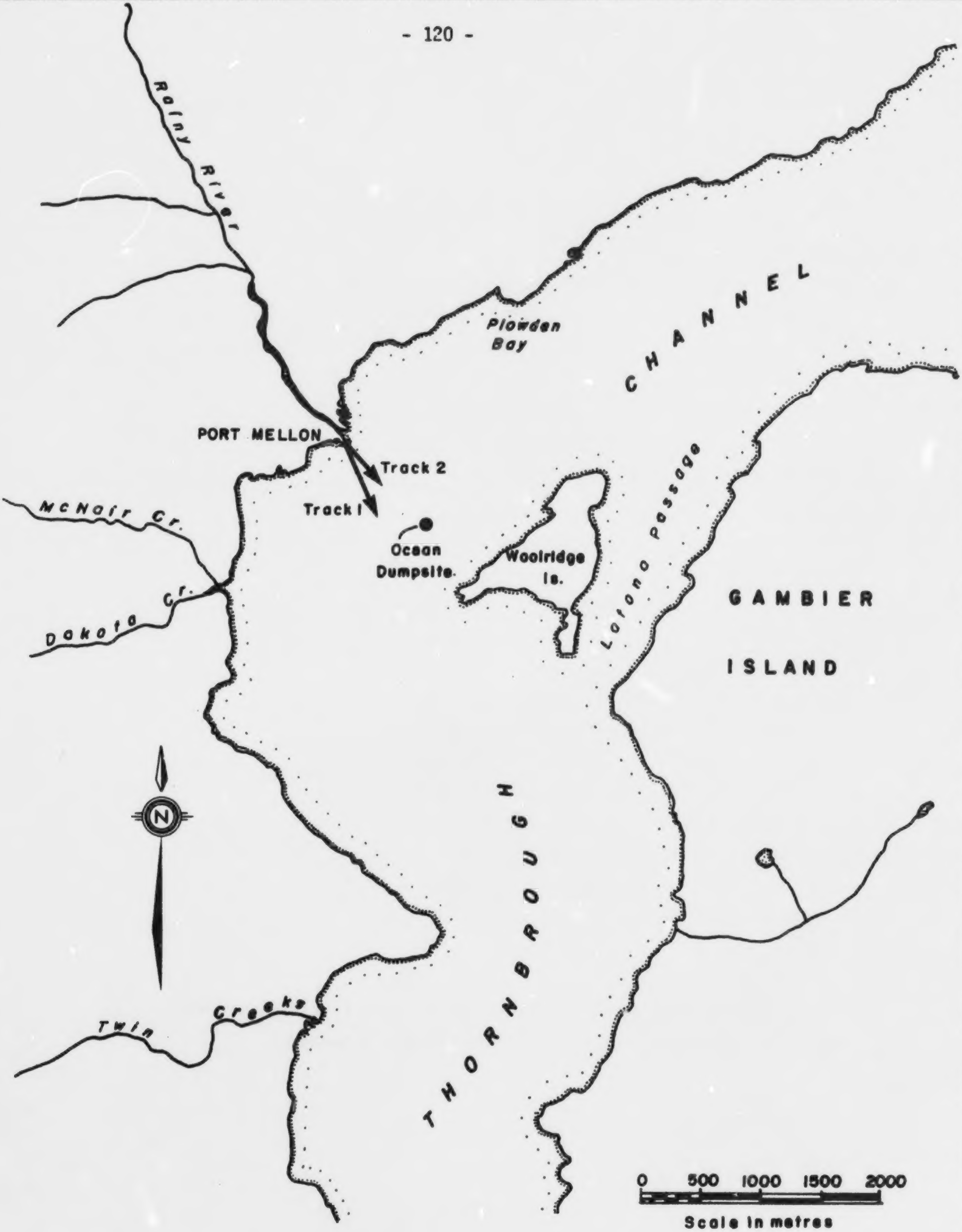
Rainy River
Plowden Bay
CHANNEL
PORT MELLON
Track 2
Track 1
McNair Cr.
Dakota Cr.
Ocean Dumpsite
Woolridge Is.
Latona Passage
GAMBIER ISLAND
N
THORNBROUGH
Twin Creeks
0 500 1000 1500 2000
Scale in metres

FIG. 34 PISCES DIVE TRACKS, PORT MELLON (1981).

PISCES IV DIVE RECORD

Location: Northumberland Channel (Harmac) Date: 25 & 26 February 1981

Dive No.: 991 (track 2), 992 (track 1), 993 (track 3) (Fig. 35)

Observers: M. Pomeroy

Position:	Start	Turn	Finish
track 2	48°08.68'N 122°51.13'W	48°08.68'N 122°51.47'W	48°09.15'N 122°51.37'W
track 1	48°09.25'N 122°52.13'W		48°09.27'N 122°51.35'W
track 3	48°08.55'N 122°50.13'W	48°08.80'N 122°50.57'W	48°08.97'N 122°51.23'W

Depth: 90m (track 2)
114m (track 1)
97m (track 3)

Clumps of material varying in size from tennis balls to several cubic feet have been reported by shrimp trawlers over a considerable portion of Northumberland Channel during the past two years. The material has been described as strong smelling (H_2S) and of unusual appearance (aggregates of sand, shell, wood debris and wood fibres). Some of the material received from the district fisheries officer was prepared by EPS and sent to Dr. H. Rogers (DFO) for subsequent analysis. A tetrahydropimaric acid and a diterpene hydrocarbon, both uncommon in wood extracts, and a number of wood sterols were identified. Dr. Rogers considers the sample to have contained resin acids probably originating in mill effluents, which had undergone substantial bacterial breakdown under anaerobic conditions making them difficult to identify.

Bioassays performed by Ron Watts (EPS) indicated the material to be highly toxic to fish. 96 hr. LT_{50}: 20 to 24 hrs. at 4.2% by volume of unextracted sample.

Based on the above findings, a Pisces dive was requested to investigate bottom conditions in the area.

Track 2 (1st Dive):

Approaching the outfall pipe on the first leg of the track, the substrate consisted of silt overlying firmer sediments. Prawns (Pandalus platyceros), shrimp (Pandalus sp.), and crab (Cancer magister) were abundant along with large sea anemones (Metridium sp., Stomphia sp.) and sea pens. Ratfish (Hydrologus colliei), rockfish, ling cod and sole were most abundant around the pipe itself.

The effect of current action was evident along the pipe. On acquisition, it was setting on the surface, but further from shore it was variously covered by sediment to 1/3 to 2/3 of its height. In places the pipe was undercut to ca. 0.5m for a distance of up to 10m. Current at the bottom (approximately 90m) was S.E. at .5 km./hr.

Visibility in the water column was about 4 to 5m on reaching the bottom and decreased slightly closer to the outfall pipe. This distance decreased to 2 to 3m as the diffuser was reached. At the termination of the dive, visibility was 1 to 2m. A mixture of zooplankton and fibre material existed throughout the column, increasing in concentration below 20m.

Small isolated patches of white material about 0.25m in diameter were encountered along both legs of the track. These were reported in past Pisces dives at this location and were considered to be a mixture of fungal/bacterial growth responding to wood fibre-debris deposition. Most of the white patches appear in small depressions in the sediment where material collects.

The gravelly substrate immediately at the end of the diffuser graded into an area of gravel and wood debris (chips and bark) extending out 10 to 20m. Crabs, prawns, shrimp and rockfish were still abundant in the region. The white patches were becoming more prevalent and at about 40 - 45m from the diffuser became heavy covering the bottom with a thin layer. Species diversity and abundance began to decrease at this point. At a depth of 98m at an estimated distance of 70m from the diffuser a heavy fibre bed was located. The bottom was very unconsolidated and 'jelly-like' in nature and was easily disturbed to reveal black reducing sediments which rapidly mixed and surrounded the Pisces. The bed appeared to be at least one metre deep. This condition extended cross-channel to a rock outcropping where the dive terminated. The only benthic fauna in the area of the fibre bed were a few shrimp and prawns in its surface and small anemones on protruding rocks.

Track 1 (2nd Dive):

Results of the second dive further north in Northumberland Channel were similar to the first. On first reaching the bottom at 114m visibility was about 2 to 4m. Crabs, prawns, shrimp, anemones, ratfish, rockfish and sole were present but in lower abundance compared to the first dive. At 109m about one quarter way along the track, isolated white patches were located on an unevenly rolling bottom. The distribution of white material became greater and by 101m (half way along the track) the fibre bed had been located. It was again soft and reducing, the submersible sinking to its ports (ca. 1m) in the material. Little life was evident on the mat aside from a few shrimp and prawns on the surface and anemones on protruding rocks and logs. The fibre bed was followed cross-channel to the rock outcropping at Gabriola Island. At 62m, below the booming grounds near the island, the fibre mat became somewhat less prominent with considerable amounts of wood debris present.

Track 3 (3rd Dive):

This dive was made south of the diffuser to locate the southern extent of the fibre bed. At point of descent, the bottom at 41m had a soft silty surface layer (ca. 15 - 20 cm) with a firm layer below. Numerous rocks and boulders dotted an irregular bottom. Ratfish, cod, rockfish, crab, shrimp, prawns and anemones were present in moderate numbers. Visibility was between 2 - 3m with considerable particulate matter in the water drifting southeast. These conditions prevailed out into the channel along the first leg of the dive to a depth of 73m. Brittle stars, squat lobsters and sole were noted at this point.

Having not encountered any white fibre material to this point, a 90° turn to the north was made towards the diffuser. The bottom was rocky and irregular with crab, shrimp and ratfish abundant. At 83m, about 2/3 along the second leg, the white deposit was discovered, forming a mat at 97m ca. 3/4 along the second leg of this track. The physical appearance of the bed was as reported for the past two dives, the only difference being the presence of a few crabs on its surface.

Conclusion:

An unconsolidated fibre bed at least 1m deep in places exists below 97m on the Gabriola Island side of Northumberland Channel. We were able to locate its southern extent but a further dive is needed to delineate the northern limit. The approximate known extent is shown on Figure 35 and covers an area ca. .5 km wide by 1.6 - 2.0 km long. From the three dives, coverage varies from light to heavy but appears fairly complete.

The effect on benthic fauna was obvious with diversity and abundance dropping rapidly as the fibre bed was reached. Crabs and shrimp occurred on the surface of the bed. Anemones were present on rocks protruding from the surface of the bed. Rockfish and ratfish swimming over the bed were infrequently noted.

No clumps of material resembling those reported in the past were seen during the dive. The presence of the large fibre mat with adjacent natural sediment in the area where shrimpers operate suggest a possible source of the 'pitchball' material. The snowballing effect of fibre and natural substrate in the net may be forming artificical aggregates.

3.3 MINES, SMELTERS, AND QUARRIES

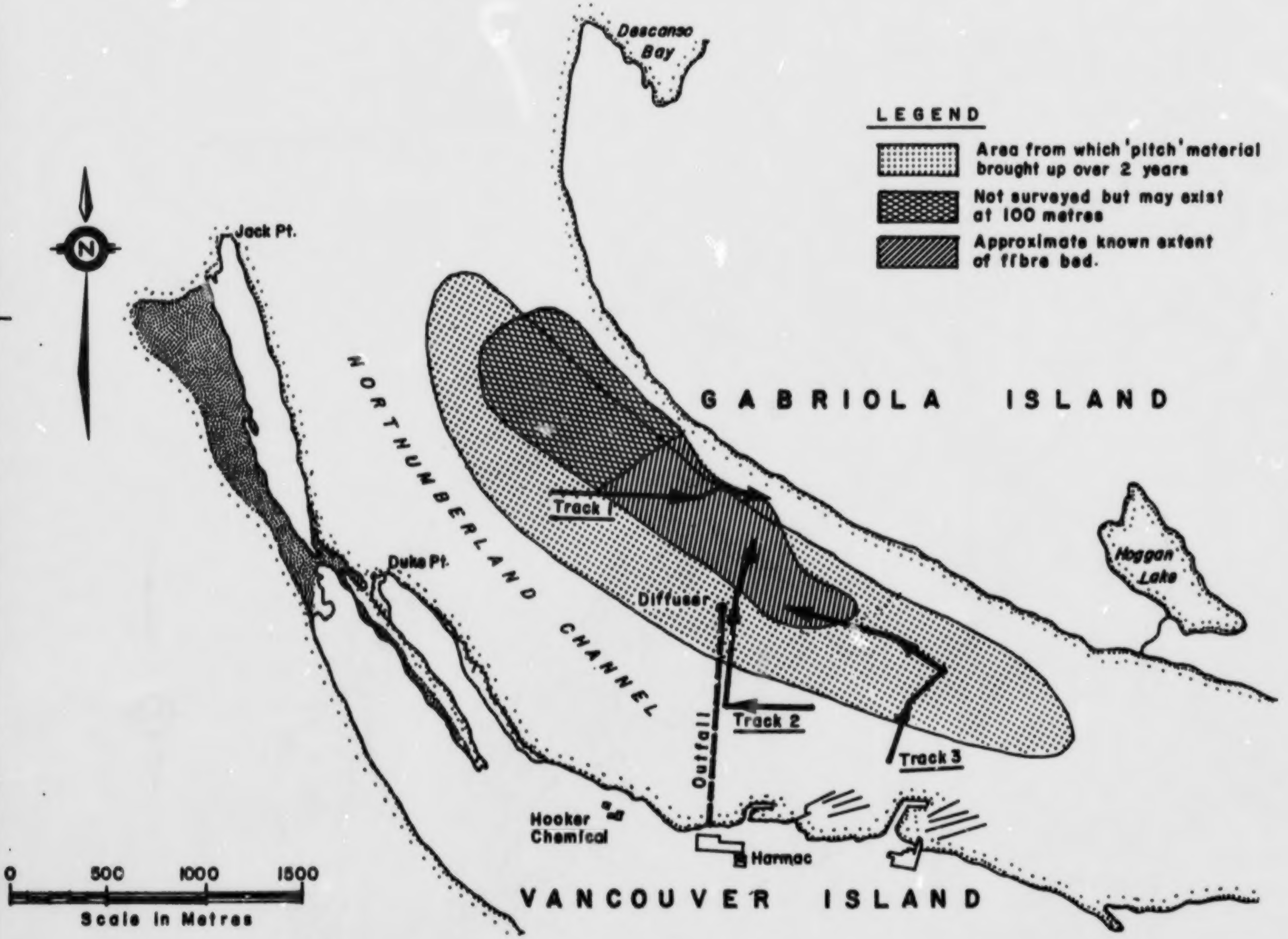
Descanso Bay
LEGEND
Area from which 'pitch' material brought up over 2 years
Not surveyed but may exist at 100 metres
Approximate known extent of fibre bed.
N
Jack Pt.
GABRIOLA ISLAND
NORTHUMBERLAND CHANNEL
Track 1
Duke Pt.
Hoggan Lake
Diffuser
Outfall
Track 2
Track 3
Hooker Chemical
Harmac
0
500
1000
1500
Scale in Metres
VANCOUVER ISLAND

FIG. 35 DIVE TRACKS AND FIBRE BED EXTENT (HARMAC - February 25-26, 1981)

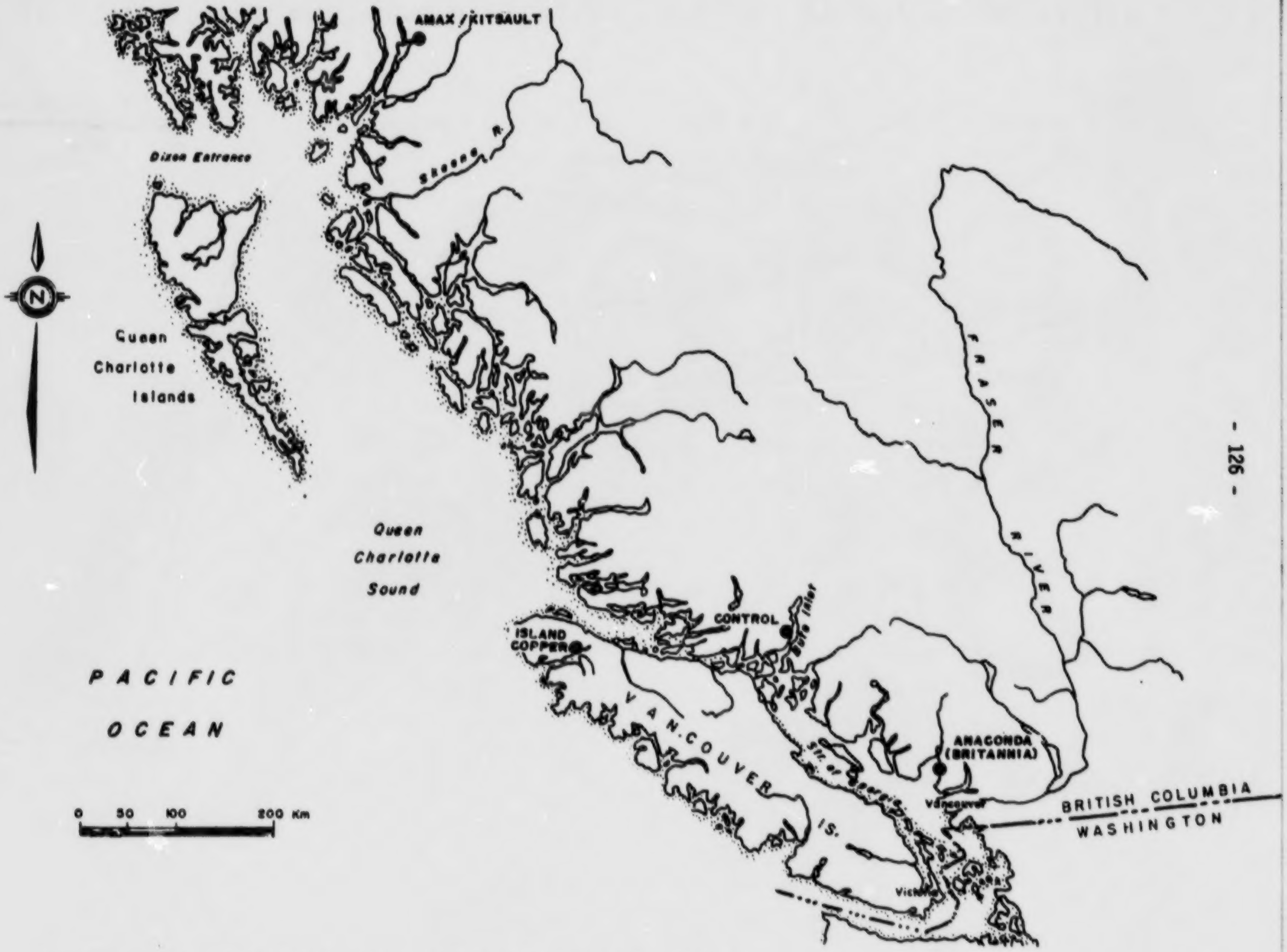
AMAX / KITSAULT
Dixon Entrance
Skeena R.
Queen Charlotte Islands
Queen Charlotte Sound
FRASER RIVER
CONTROL
Bute Inlet
ISLAND COPPER
PACIFIC OCEAN
VANCOUVER IS.
Str. of Georgia
ANACONDA (BRITANNIA)
Vancouver
BRITISH COLUMBIA
WASHINGTON
Victoria
N
0 50 100 200 Km

FIGURE 36 LOCATION OF COASTAL MINING SITES

PISCES IV DIVE RECORD

Location: Holberg Inlet (off Pot Rock) Date: 11 February 1975

Dive No.: 294 (Fig. 37)

Observer: D. Goyette

Position:

	Start	Finish
	50°35.0'N	50°35.0'N
	127°39.4'W	127°39.1'W

Depth: 115m

OBSERVATIONS:

30m - Water murky, visibility approximately 1.8 metres (end of orange claw). Individual suspended particles distinguishable.

50m - Few chaetognaths appearing.

65m - Visibility approximately 1.8 metres.

75m - Increase in particulate matter, zooplankton not in significant numbers.

100m - Visibility reduced due to large particles in suspension.

115m - On bottom, visibility 0.6 metres, bottom covered in tailings, numerous craters, few shrimp (Pandalid) observed. Fish observed were hake, eelpout, sole, ratfish.

80m - Moved to new position, tailings present, visibility improved but insufficient for adequate observations, a few shrimp observed.

50m - Visibility moderate, rocky bottom, light brown sediment, no tailings observed, few rockfish, starfish (Pseudarcaster sp.), and shrimp observed.

40m - Substrate small rocks, visibility approximately 3 metres.

20m - Returned to surface.

REMARKS:

Visibility was very poor at 115 metres and improved slightly above 50 metres. Observations were limited and Pisces operations difficult. The reduced visibility was due to a high concentration of brown coloured particles suspended in the water. No definite layering of either turbidity or zooplankton was observed. Tailings (from the distinct grey colour) were evident up to a depth of 80 metres and not seen at 50 metres.

PISCES IV DIVE RECORD

Location: Rupert Inlet (centre channel, abeam of Red Island)
Date: 11 February 1975

Dive No.: 295 (Fig. 37)

Observer: D. Goyette

Position:

	Start	Finish
	50°35.25'N	50°35.25'N
	127°27.40'W	127°27.40'W

Depth: 90m

OBSERVATIONS:

10m - Fine particles suspended in the water producing a milky grey appearance.

25m - Halocline observed.

60m - No zooplankton observed to this depth.

85m - A few euphausids and hyperid amphipods appearing. Size of suspended particles increasing.

90m - On bottom. Bottom not visible due to high turbidity, appearance of water similar to a very dense fog. Distance - viewport to bottom approximately 0.7 metre. Returned to the surface.

REMARKS:

Entire water column extremely turbid with visibility ranging between 1.8 metres at the surface to less than 0.3 metre below a depth of 60 metres. Appearance of the water column, surface to the bottom, similar to a dense fog. Visibility decreased gradually with no distinct layering. Fine suspended particles throughout the water column giving it a definite grey colour. Lack of visibility prevented observations and photography. Unable to see the bottom, approximately 0.7 metre from viewpoint. Particles extremely fine, unable to distinguish individual particles until near the bottom. Increase in particle size possibly due to flocculation.

PISCES IV DIVE RECORD

Location: Rupert Inlet
(centre channel, abeam of Red Island)

Date: 12 February 1975

Dive No.: 297 (Fig. 37)

Observers: D. Goyette and C. Pelletier

Position:

Start	Finish
50°35.35'N	50°35.35'N
127°26.70'W	127°26.70'W

Depth: 75m

OBSERVATIONS:

Transmissometer readings were recorded during the descent:

Surface - 18%
15m - 26%
30m - 12%
35m - 9%
50m - 5%
70m - 4%
75m - 3% (bottom)

Little change in visibility over Dive No. 295 in the same area. Dense grey fog throughout water column. Size of many of the suspended particles appeared to increase near the bottom. Contact with the bottom at 75 metres.

REMARKS:

Unable to observe the bottom. Dive was terminated soon after colliding with an underwater object.

PISCES IV DIVE RECORD

Location: Holberg Inlet (west of Straggling Islands) Date: 13 February 1975

Dive No.: 298 (Fig. 37)

Observer: H. Nelson

Position:

	Start	Finish
	50°36.00'N	50°35.10'N
	127°43.90'W	127°44.00'W

Depth: 90m

OBSERVATIONS:

Transmissometer readings on descent:

Surface - 51% transmissibility
25m - 36%
50m - 26%
90m - 7% on bottom

Visibility poor, worse than Dive No. 294 (Pot Rock). Particle size larger than that observed in Rupert Inlet. Ascended to 50 metres depth for better visibility and headed to north shore. Contacted bottom again at 65m. Transmissibility at 65m was 22%, substrate soft mud, no evidence of tailings on the bottom. Numerous craters, few shrimp. Plankton (chaetognaths, amphipods, small euphausids) fairly abundant during descent.

PISCES IV DIVE RECORD

Location: Near head of Holberg Inlet 13 February 1975

Dive No.: 299 (Fig. 37)

Observer: H. Nelson

Position:

	Start	Finish
	50°37.9'N	50°38.15'N
	127°54.9'W	127°54.70'W

Depth: 55m

OBSERVATIONS:

Transmissometer readings on descent and ascent:

Surface - 60 - 70% transmissibility
50m - 40%
55m - 50% on bottom
45m - 30% "
40m - 26% "

Many plankters observed during descent. Contacted bottom at 55m, visibility 2.4 to 3.0m and murky. Substrate soft, brown mud; numerous craters up to 10 cm. in diameter. Amphipods and euphausids abundant during descent. Several flat fish observed. Size of suspended particles smaller than those seen on Dive No. 298. At 45m moving towards shore, little change in substrate, few shrimp, occasional eelpout. Visibility descreased towards shore, increase in marine life, eg., pandalid shrimp, eelpouts, flatfish (15 to 20 cm. long) frequently observed. At 40m water murky; a few anemones, number of large empty clam shells, many zooplankters (mostly euphausids) observed. At 20m, ascended to surface.

PISCES IV DIVE RECORD

Location: Quatsino Sound, West of Drake Island Date: 14 February 1975

Dive No.: 300 (Fig 37)

Observer: D. Goyette

Position:

	Start	Finish
	50°29.09'N	50°30.23'N
	127°44.65'W	127°45.35'W

Depth: 125m

OBSERVATIONS:

Surface - Visibility very good, clear.

25m - Water colour dark blue, increase in suspended particles compared with the surface but water clarity remained extremely clear.

35m - Increase in size and concentration of suspended particles, no sign of zooplankton, suspended particles appear as brown to whitish coloured matter, short (20.3 mm) strings to small spheres (presumably diatom).

50m - Few chaetognaths appearing; odd, small euphausid

65m - Number of small euphausid increasing.

75m - Concentration of suspended particles remaining relatively uniform, chaetognaths and euphausids the dominant plankton.

100m - Holding at 100m to attach more line to surface buoy, number of white flecks observed, similar in size and shape to herring scales.

120m - On the bottom, visibility very good, approximately 4.5m; light brown to slightly grey colour to sediment, no sign of tailings; mud very soft, vibrates ahead of sub when skids touch; number of shrimp present; substantial numbers of chaetognaths (most dominant plankton); number of large (5.0 to 7.6 cm.) shrimp observed;

increase in the number of Hyperid amphipods, 40 to 50 chaetognaths observed at any given time; several small (2.5 cm.) orange coloured pelagic polychaetes; one pteropod (pelagic mollusc); bottom smooth with numberous large craters; large numbers of Pandalid shrimp (*Pandalopsis dispar*); a number of flatfish, eelpouts, ratfish, hake, small orange-banded rockfish; several clumps of cloud sponge 0.3 to 0.6m in diameter.

105m - Steep mud incline.

100m - Bottom changed to coarser sediment, rock cod, sea urchin; large number of shrimp observed.

75m - *Crossaster* sp., *Pseudarcaster* sp.

70m - Clump of cloud sponge.

65m - Large numbers of *Psolus* (creeping cucumber) on small rocks; large numbers of squat lobsters and *Munida* sp. Substrate type has a definite relationship to the species observed.

60m - Sea anemone; number of boot sponge (*Hexactinellida*) similar to those commonly seen in Saanich Inlet; bottom consisted of rock and coarse sediment; several large schools of rockfish; noticeable increase in variety of marine life over that observed at 120m.

50m - Area of large boulders; further increase in amount of marine life; large schools of rockfish, *Parastichopus* sp; bottom changing to coarse gravel and sand; decrease in the number of shrimp; large skate; pink and white banded rockfish; water slightly murky

30m - Gravel bottom, occasional boulder; wood debris (natural).

25m - Left bottom; steep cliff; visibility 5.5 to 6.0m.

REMARKS:

Visibility excellent, making Pisces operation easier than previous dives. No evidence of the grey coloured suspension which was noted in Rupert Inlet.

Although the concentration of suspended particles was relatively high, the water between the particles was clear, giving excellent visibility (to the maximum penetration of the submersible's lights). Plankton abundant below 65m with very large concentrations of chaetognaths. Area extremely rich in marine life with a variety of fish and invertebrates. Pandalid shrimp very abundant up to 50 metres. Numbers and presence of shrimp appear to be associated with mud bottom. Increase in numbers of rockfish associated with boulders or rocky areas. Numerous craters observed in the mud bottom. Craters have been seen frequently in Alberni Inlet, Indian Arm, and Howe Sound. Craters appear to be formed by an unidentified organism. Craters end in a well-defined and maintained hole approximately 3.0 to 7.6 cm in diameter which frequently leads off at right angles to the base of the crater. No tailings observed at any depth.

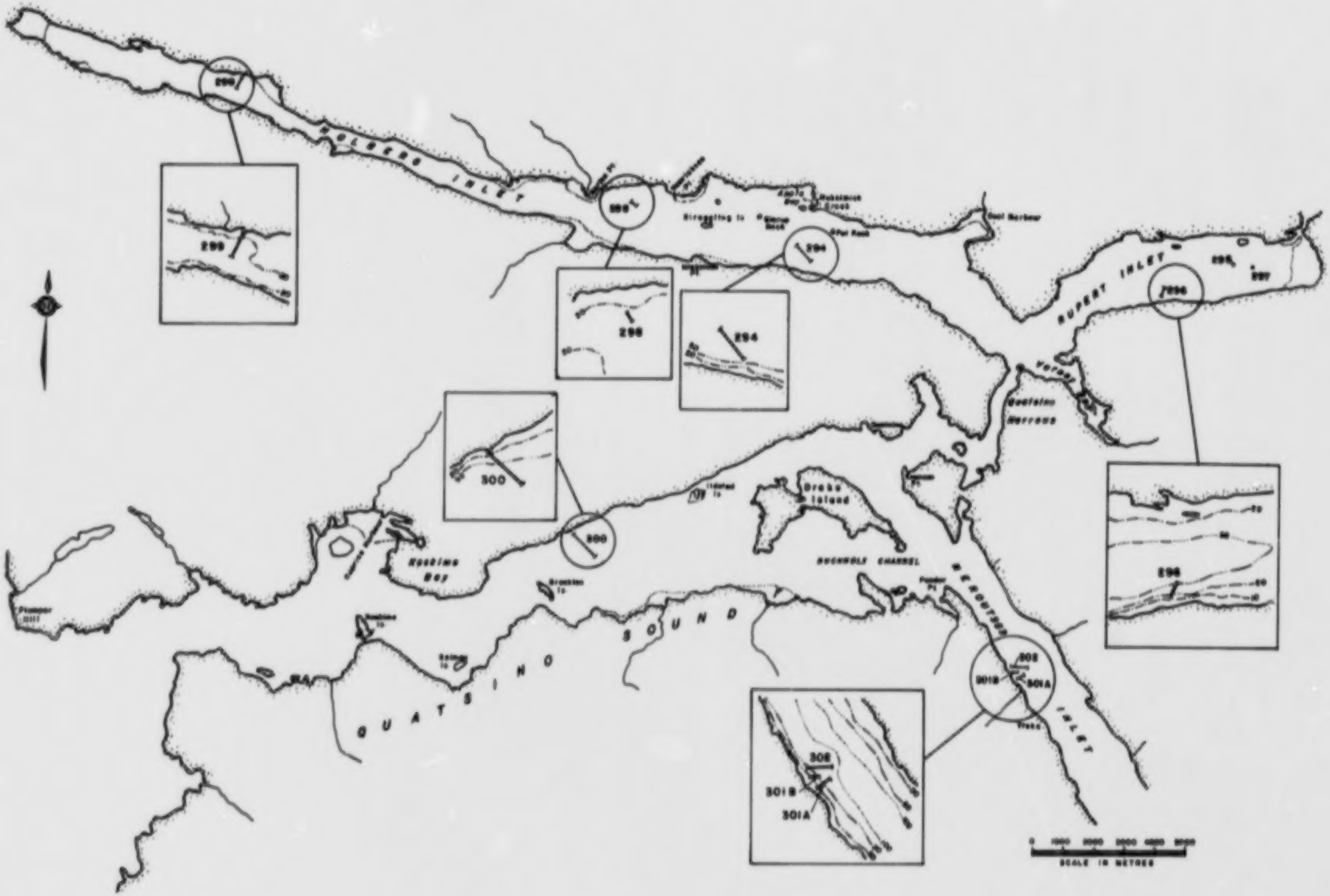
HOLBERG INLET
RUPERT INLET
NEROUTSOS INLET
QUATSINO SOUND
Drake Island
BUCHHOLZ CHANNEL
Koskimo Bay
Quatsino Narrows
Varney Bay
Coal Harbour
294
296
298
300
301A
301B
302
295
297
SCALE IN METRES

FIG. 37 PISCES DIVE TRACKS, QUATSINO SOUND (1975)

PISCES IV DIVE RECORD

Location: Howe Sound

Date: 23 August 1976

Dive No.: 460 (Fig. 38)

Observer: D. Brothers

Position:	Start	Turn	Finish
	49^{9}29.70'N	49°29.50'N	49°29.85'N
	123°17.15'W	123°17.15'W	123°17.75'W

Depth: 240m

OBSERVATIONS:

Surface	- Visibility 1.5m. Turbid fresh water layer down to approximately 8 metres. - Increased visibility below fresh water layer 3m - 4m.
8-100m	- White particulate suspended matter in water column (detritus?); few ctenophores; some zooplankton.
100-240m	- Abundance of zooplankton and detritus.
200-240m	- Highest concentration of zooplankton. Many small fish (soft eelpout, lantern fish, other unidentified).
Bottom	- 240m, bottom appears to be brownish material sediment. - Proceeding south along bottom 240m - 200m visibility 2-3m, biota observed: - Spirontocaris sp. - many - "Football" anemone - 4 or 5 - Mud stars - 2 Ctenodisous sp. - Pandalus borealis - some - Pandalopsis dispar - few - Eelpouts, blackfins, pricklebacks - Ratfish - 2 or 3 - Squid - 1 (40 cm. approximately) - Short spined thornyhead - many - Burrowing anemone (dark brown) - Large snails Neptunex sp. - many tracks - Small white sponge 7-10 cm. - Munida quadrispina - very few - Two flatfish (unidentified)

- Proceeding course 270°; up incline 200m - 100m; visibility 3m - 4m. Biota observed:
  - Blackfin and/or eelpout
  - Chinonoecetes bairdi - tanner crabs at a definite depth
  - Flatfish
  - Prawns Pandulus danae
  - Drastic increase in members of shrimp (all three species mentioned above)
  - Rockfish
  - Few matridium
    (rock outcroppings now appearing)
  - Pseudarchaster sp.
  - Pycnopodia sp.
  - Munida - very abundant
- Proceeding up incline 100m - 10m (rock outcropping more frequent)
  - Abundance of sponge display, Munida, and Metridium sp.
  - More prawns, fewer shrimp
    (Cobble-type rocks in this area)
  - Nudibranch
  - Decorator crabs
  - Parastichopus sp.
    (20m - 10m)
  - Increasing numbers of Metridium sp. to "forests".
  - Incredible sponge displays
  - Many rockfish (predominantly same spieces)
  - Mediaster eaqualis
  - Evasterios troschelli (?)

PISCES IV DIVE RECORD

Location: Howe Sound

Date: 23 August 1976

Dive No.: 461 (Fig. 38)

Observer: D. Goyette

Position:	Start	Finish
	49°35.30'N	49°33.40'N
	123°14.75'W	123°15.40'W

Depth: 285m

OBSERVATIONS:

Surface	- murky 1.3m, claw barely visible
	- surface layer freshwater, approximately 10m
	- water clear below surface, numerous white particles suspended throughout watercolumn.
	- Zooplankton dominantly amphipods.
	- Numbers increasing at a depth of 150m.
	- Lantern fish observed at 175m.
Bottom - 285m	- visibility poor, approximately .3 - .6m.
Sediment	- light brown surface layer with patches of grey in areas disturbed by burrowing animals.
	- Few eelpouts (black belly), sole, and pandalid shrimp observed. Visibility poor. Left bottom and headed west for clearer water. Suspended sediment concentrated near the bottom in the central areas of Howe Sound.
	- Contacted bottom again at 285m (inshore). Visibility improved. Base of steep cliff at 285m.
	- Large numbers of prawns, pink shrimp, and *Munida* observed.
	- Rock face covered with thick layer of grey sediment (tailings). Sampled from skids by surface dives for analysis. Few rock fish, sculpin, and dogfish observed on ascent. Occasional *Cancer magister* at 50m. Numerous burrowing anemones in soft sediment along the ledges.

- Fewer numbers of shrimp at 50 metres. Very little evidence of wood debris.

SUMMARY

Visibility very poor near centre channel. Visibility improved at 80m depth in inshore areas. Few eelpouts and shrimp observed, no pelagic fish observed near centre channel.

Munida and prawns very numerous at 100m. Fewer in shallower regions. Shoreline - steep rocky slope covered by sediment similar to tailings. Burrowing anemones common.

Marine life less abundant than dive 460 (pilot observation). More sediment covering cliff face than dive No. 460.

PISCES IV DIVE RECORD

Location: Howe Sound (Britannia Mine) Date: 24 August 1976

Dive No.: 462 (Track 2) (Fig. 38)

Observer: D. Sullivan

Position:

Start	Finish
48°37.56'N	48°37.57'N
123°13.29'W	123°12.47'W

Depth: 235m

Descent:

- detrital material to 75 metres; below this depth abundant planktonic life; Lantern fish common

Bottom (235m)

- Visibility 2.5 - 3m; slightly murky
- bottom very silty, soft; sole, tanner crabs, shrimp noted; eelpouts common
- proceeded east toward Britannia Mine
- tailing ridges encountered at 175 metres; very steep; few rock outcroppings noted; manoeuverability difficult
- bottom life similar but reduced
- visibility reduced to 1m.
- cancer and tanner crabs noted
- few shrimp, eelpouts, sole, Colus sp., sculpin (Dasycottus)
- bottom very silty in this area, flat, beige colour on surface, grey to black underneath
- tailing ridges continue
- Dive ends 70 metre depth, 1318 hours.

PISCES IV DIVE RECORD

Location: Howe Sound (north of Britannia Mine)

Date: 24 August 1976

Dive No.: 462 (Track 3) (Fig. 38)

Observer: D. Goyette

Position:

	Start	Finish
	49°37.95'N	49°38.1'N
	123°13.07'W	123°12.9'W

Depth: 235m

OBSERVATIONS:

Visibility - 3 - 3.5m below surface layer

Upper 50m - mostly detritus, sparse phytoplankton and zooplankton

No macro-zooplankton observed to 70m

Amphipods appearing at 75m

100m - same abundance of zooplankton

- occasional siphonophore, no euphausids observed, largely amphipods

No change in visibility and plankton abundance to 175m, occasional pelagic shrimp and lantern fish observed.

Copepods abundant near bottom.

On the bottom at 235m - visibility lowered to 2.5 - 3m (murky)

Catshark (1), ratfish

Contacted bottom on a steep slope, heading towards shore. Sediment - grey in colour covered with a thin brown surface layer.

Several tadpole snail fish (Nectolysaris pelagicus) observed near the bottom.

Numerous small pandalid shrimp (Spirontocaris, few Cancer magister)

Considerable evidence of burrowing

Headed towards shore along a narrow tailings ridge running perpendicular from the shore. Ridge extended to base of a cliff to a depth of 60m.

Bottom similar to dive 462 (2)

Cancer magister - numerous around a depth of 75m, few tanner crab

Rock ledges covered by tailings - few surpulid polychaetes, solitary corals on bare rock.

Upper 15m - free from sediment, barnacles, many slipper shell (Crepidula), occasional rock fish.

PISCES IV DIVE RECORD

Location: Howe Sound
(east shore north of Watts Point)

Date: 25 August 1976

Dive No.: 463 (Track 2) (Fig. 38)

Observer: D. Goyette

Position:

Start	Finish
$49^{0}39.78'N$	$49^{0}39.52'N$
$123^{0}12.18'W$	$123^{0}11.85'W$

Depth: 170m

OBSERVATIONS:

Surface visibility approximately 30 cm.
Fresh water evident to 10m.
Visibility increased below 10m - clear.
Few amphipods, mostly detritus.

Numbers of amphipod increase - at 80m.
Several small white coloured squid.
No. euphausids or fish observed during descent.

Bottom at 200m - visibility approximately 2.3m.
Few eelpouts, ratfish, hake, numerous holes in sediment. Sedminet soft and light brown in colour.

Headed toward east shore - bottom contour - series of ridges running perpendicular from shore
- encountered several ledges above 70m which ran parallel to the shoreline

170m
- lemon sole (1), sidestripe (1)
- visibility lowered to 1.2m
- few snails (Colus?), occasional shrimp (pandalid), few small ratfish, black belly eelpouts (few)
- several Chirodota seen lying on surface

150m
- slope increasing

120m
- few prawn appearing
- starry flounder (1)

100m
- numbers of pandalid shrimp increased (pink shrimp and

	Spirontocaris) - occasional larger shrimp, presumably sidestripes
75m	- wood debris
50m	- visibility decreasing - still following ridge - more evidence of sediment along east shore compared to west shore (dive 463 (1)) - *Cancer magister* becoming very numerous, 10-15 seen at a time - estimated 100-200 crabs within a small area - light coloured pandalid shrimp appearing - fewer number of fish over other dives - numbers of *Munida* concentrating around wood debris - sedge ball observed - numerous burrows - occasional flatfish, *Munida* not present in areas of soft sediment - occasional blackbelly eelpout, prawn
25m	- sea pens
15m	- terminated dive - sediment present observed to a depth of 15m.

Most dominant species during dive was the pandalid shrimp and, at 50-70m, *Cancer magister*. Marine life in deeper depth not overly abundant and very little diversity.

PISCES IV DIVE RECORD

Location: Howe Sound
(Thornbrough Channel, off McNab Creek)

Date: 26 August 1976

Dive No.: 464 (Fig. 38)

Observer: H. Nelson

Position:	Start	Turn	Finish
	$49^{o}32.88'$N	$49^{o}33.12'$N	$49^{o}33.55'$N
	$123^{c}23.28'$W	$123^{o}22.80'$W	$123^{o}22.52'$W

Depth: 230m

OBSERVATIONS:

Good surface visibility. On descent, large inert particles with a few plankters.

100m - the number of large particles decreased, number of zooplankters increased. Visibility good.

200m - many pelagic amphipods, several Ctenophores and a few fish approximately 5 cm. long. Visibility decreasing.

230m - on the bottom visibility 4m. Substrate a skiff of brown sediment over fine grey sediment.

Moving over the mud bottom, animals observed were:

- several shrimp (Spirontocaris sp. and sidestripes, Pandolopsis dispar.)
- a few large anemones (football) and Metridium sp.
- several eel pouts.
- large Gastropods
- a few orange starfish (Pseudarcaster).
- many large sidestripes and squat lobsters (Munida sp.)
- single spider crab, single Cancer magister
- single rock fish (red snapper), single skate
- few sculpins, pelagic shrimp
- few brittle stars
- at 1030 hours the bottom life has not changed appreciably. No flounders or sole have been observed.

- at 1035 hours more wood, bark, and leaves cover the bottom.
- a few flounder and sole have been seen
- jelly babies (*Chiridota laevis*)
- large brittle stars
- single octopus, single *Squalus* sp., single hake

190m - another substrate change to sand, boulders, and leaves
- several prawns
- very abundant *Munida* sp.

100m - ling cod, *C. magister*
- passed over a ridge of fine sediment, presumably originating from McNab Creek

70m - begin moving up cliff face, visibility good, approximately 10m
- many sponge; *C. magister*, anemones, tube worms, clam shells, starfish in clear sphere?

SUMMARY

Three substrate types encountered each with a corresponding change in benthic communities, both qualitative, and quantitative as noted. Habitat very important in structuring bottom communities. These are enhanced by introduction of wood debris (logs, bark, chips, leaves).

PISCES IV DIVE RECORD

Location: Howe Sound (Thornbrough Channel off Hillside Gravel Pit)

Date: 26 August 1976

Dive No.: 465 (Fig. 38)

Observer: H. Nelson

Position:

	Start	Finish
	49°30.35'N	49°30.21'N
	123°28.82'W	123°29.47'W

Depth: 220m

OBSERVATIONS:

	Surface visibility fair Descending, large inert particles (white) in suspension
100m	- siphonophores, amphipods, ctenophores, cumaceans, megalops
150m	- inert particles smaller, pelagic shrimp, large lobed ctenophores, small fish
220m (bottom)	- soft substrate, mud. Visibility 3.5m - many zooplankters, mainly copepods - several sea pens (sea whip), eel pouts, burrowing anemones - *Spirontocaris* sp., *Munida* sp., several prawns, large gastropods (*Neptunia* sp.) on logs - single red snapper, single Tanner crab .
145m	- moving towards Hillside Gravel Plant - encountering wood debris, logs and bark - increasing numbers of prawns, *Metridium* sp., *Munida* sp. (very abundant and large), snails - single red snapper
50m	- logs and *Metridium* sp. - moving out from under log booms and heading south off bottom.

125m - back on bottom, usual benthos, single octopus, few _Ctenodiscus_ sp.
- begin ascent

SUMMARY

Benthic communities in this area were quite similar to those encountered off McNab Creek (Dive No. 464). However, no flounder or sole were seen and prawns were present in greater numbers. The _Munida_ sp. off Hillside, present in large numbers around the wood debris, seemed to be larger. Very large _Metridium_ sp. on the logs.

PISCES IV DIVE RECORD

Location: Thornbrough Channel
(Centre Channel east to Woolridge Island)

Date: 27 August 1976

Dive No.: 466 (Fig. 38)

Observer: D. Goyette

Position:

Start	Turn	Turn	Finish
49°30.40'N	49°30.60'N	49°30.58'N	49°30.55'N
123°28.45'W	123°28.36'W	123°28.10'W	123°27.95'W

Depth: 225m

OBSERVATIONS:

Surface layer of freshwater to 10m

Visibility - clear

Few amphipods appearing at 50m

Larval fish at 75m

Few ctenophores, zooplankton not very abundant, some detritus.

Increasing numbers of zooplankton below 75m - largely amphipod, siphonophores, and occasional ctenophore, no euphausids.

Large ctenophores (Bolinopsis?) appearing at 100m. These normally seen at this depth.

125m - increasing numbers of various jellyfish, no euphausids observed (similar to previous dives)

210m - lantern fish common
- larger concentration of copepod

225m - on the bottom, visibility approximately 3.5m
- sediment - light brown on the surface
  - light grey colour in disturbed areas
- Munida very abundant, Mediastes shrimp (pandalid), Colus - common.

Few sidestripe, burrowing anemones - abundant, occasional sea whip.
Colus? very abundant along logs.
Bottom - relatively free of wood debris, only occasional log and cedar bark.
Munida very abundant around wood debris.
A number of red snappers? seen by pilot.
Few eelpouts.

Slope increasing at 225m - base of cliff - numbers of burrowing anemones increased, increase in bark and wood deposits, large amount of sponge debris at base of cliff.
Munida, anemones very numerous.
Large white anemones concentrated along logs.

200m - light film of sediment over rocks, considerably less than Howe Sound area
- large numbers of "horn" sponges growing on rock face, cloud sponge also present.

185m - continued along cliff
- "horn" sponge very abundant, many Munida inside and around clusters of sponges

Occasionally Munida seen swimming away from rock face.
Cliff face also covered with numberous brachiopods and a small white either solitary coral or anemone.
Ascending to 130m and again ran parallel to cliff
- heading south along rock face
- Munida and sponges - still very numerous

60m - numerous sponges, occasinnal glass sponge (tubular)
- occasional - yellow banded rockfish, few prawns (not as numerous as dive 465), cloud sponge - abundant

SUMMARY

Bottom conditions basically similar to dive 465 with exception of less wood debris inshore. Fewer fish observed than Howe Sound dives. Shrimp not as abundant as Howe Sound. Most abundant animals in deeper areas were Colus, Munida, and burrowing anemones. "Horn" sponge and Munida most abundant form along rock cliff off Woolridge Island. Fewer prawn than opposite shore (dive 465). Very little sediment deposition along shoreline, rock cliff heavily encrusted with sponges.

PISCES IV DIVE RECORD

Location: Centre of Thornbrough Channel (off Mannion Creek) Date: 27 August 1976

Dive No.: 467 (Fig. 38)

Observer: D. DeMill

Position:	Start	Finish
	49°27.90'N	49°27.63'N
	123°27.60'W	123°27.45'W

Depth: 175m

OBSERVATIONS:

Surface layer of freshwater to around 10m.

Some amphipods, detritus, a few small squid in water column.

Bottom - visibility 5m decreasing to 2.5m during the dive.

Sediment - gray, "tailings-like" covered with light brown skiff.

Fish - good diversity, low numbers including:
ordinary-looking eelpouts; long, thin eelpouts; small, pale fish; small, red rockfish; flounders/sole; sandab (?); hake (?), red and white rockfish; round-headed (with bumps) sculpin.

Shrimp - common - including; sidestripes; small transparent ones (frightened up into water). More sidestripes near end of dive.

Munida - numerous.

Burrows - many small clam-like, a few larger - 3 cm.

Cucumbers - many small (approximately 2 - 5 cm) white (pulled back into burrows when frightened).

Beer cans - one.

Crabs - a few small decorator crabs and one "tanner" crab.

Anemones - some burrowing anemones.

Sea pen - small white, rigid-stalked - a few.

Snails - clusters of *Thais*-like snails on logs and wood chunks.

Octopus - 1 small.

Starfish - flat, thick, armed, brown.

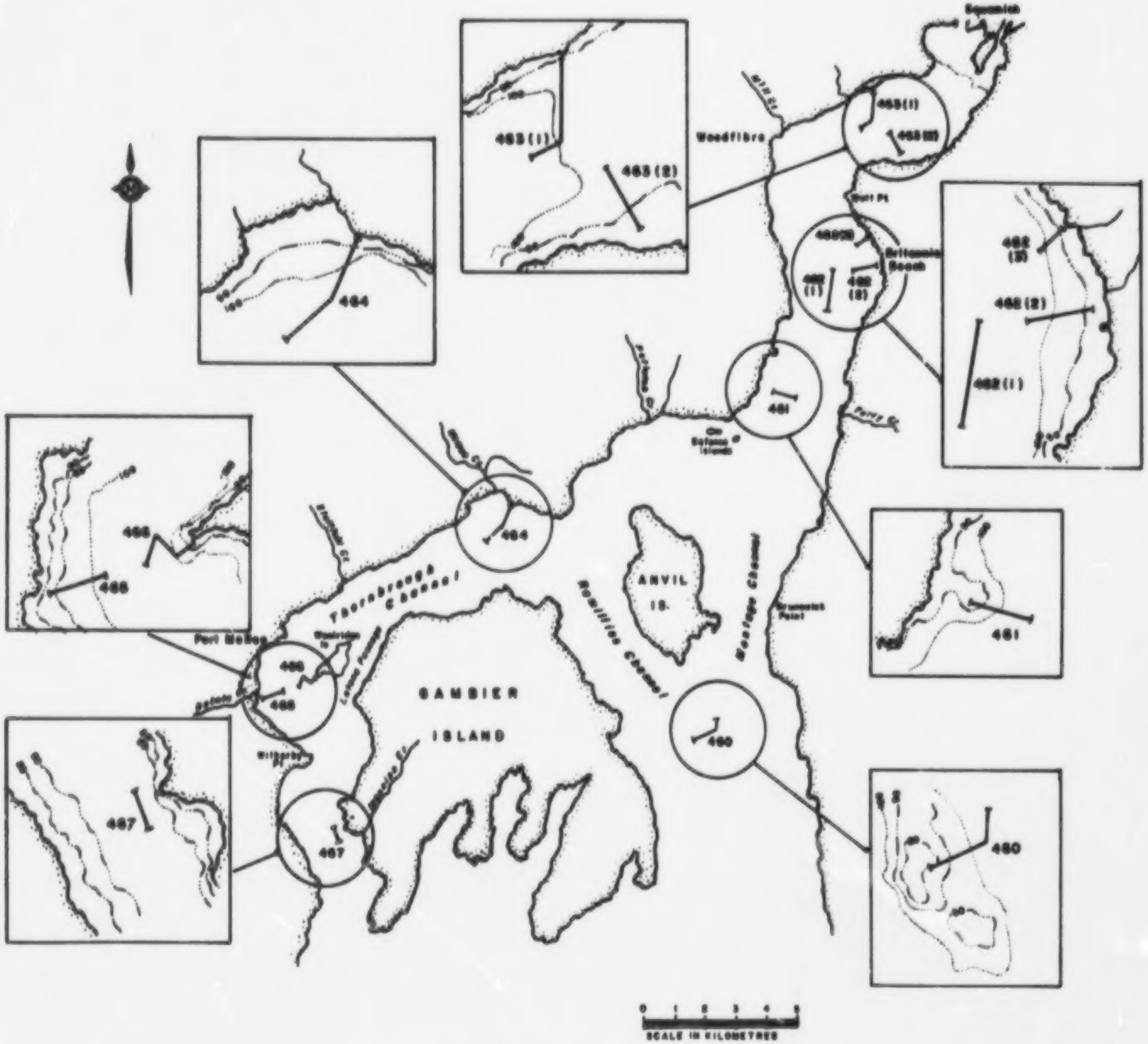
Squamish
Woodfibre
Mill Cr.
463(1)
463(2)
462(3)
462(1)
462(2)
Britannia Beach
Furry Cr.
461
Woolridge Is.
Port Mellon
464
465
466
Thornbrough Channel
ANVIL IS.
Ramillies Channel
Montagu Channel
GAMBIER ISLAND
460
467
0 1 2 3 4 5
SCALE IN KILOMETRES

FIG. 38 PISCES DIVE TRACKS, HOWE SOUND 1976.

PISCES IV DIVE RECORD

Location: Bute Inlet (Littleton Point) **Date:** 28 August 1976

Dive No.: 468 (Fig. 39)

Observer: D. Goyette

Position:

	Start	Turn	Turn	Finish
	50°49.85'N	50°50.15'N	50°50.40'N	50°50.40'N
	124°54.10'W	124°53.95'W	124°54.30'W	124°54.50'W

Depth: 380m

OBSERVATIONS:

Surface water milky green colour. Visibility approximately 5 cm. Completely submerged - visibility increased to approximately 60 cm.

5m	- visibility approximately 1.2m, white flocc in surface water.
25m	- mostly detritus, water between particles clear giving good visibility, greater than 3.5m.
50m	- occasional amphipod - few small euphausids (*E. pacifica*) - dogfish (1), few tenophores - mostly detritus
100m	- claw clearly visible - squid (3)
150m	- occasional fish - smelt?
175m	- occasional lantern fish, smelt
200m	- large squid - pelagic shrimp - large ctenophore (Bolinopsis)
250m	- numerous small fish (deepsea smelt?) - occasional ctenophore - large squid (1) - several small squid (opaque)

300m	- visibility - murky
380m	- Bottom - sediment soft and very light colour - occasional burrows - fewer than Howe Sound. Numerous pandalid shrimp, snail? tracks - no animals observed, ratfish, no burrowing anemones or flatfish observed, occasional black belly eelpouts. - visibility - murky, approximately 2.3m - Metridium (1) - Bottom smooth, relatively undisturbed, little evidence of wood debris - Eelpouts and pandalid shrimp - by far the most species, with occasional hake, ratfish, dogfish, Mediaster (starfish). Based on size shrimps are a mixture of Spirontocaris and pink shrimp.
350m	- little change - no flatfish observed - headed inshore at 330° - 1 - heart urchin, ratfish (1), mediaster, hake, small polynices (1), numberous shrimp, hermit crab, only 2 burrowing anemones - starry flounder (1) - visibility increasing - murky 3.5m
330m	- numbers of crangon shrimps appearing, 30 pandalid shrimp at approximately 1.85 km/hr - visible area estimated at 3.5m x 2.6m - 15 shrimp, 1 eelpout, 2 mediaster, 1 large pink anemone - 27 shrimp, 2 eelpout, 1 mediaster.
325m	- 15 shrimp, 1 eelpout - contact with shoreline - red snapper? bark, mostly shrimp and numerous Munida (none seen earlier in this dive) - occasional sidestripe - sidestripe more abundant closer to shoreline
280m	- steep slope - almost vertical - rock covered by thick layer of sediment, occasional rock outcripping free of sediment.

	- bare surface covered with brachiopods and few "horn" sponges and pink anemones - sediment covering rock face - mostly shrimp and *Munida* - occasional eelpout (juvenile) depth of 180m, seen floating at the bottom - coiled
150m	- few pink sea urchins, e.g., *S. drobachiensis*
75m	- little change from base of cliff
65m	- several pink sea urchins - "horn" sponge - numbers considerably less than Thornbrough Channel - occasional prawn
50m	- numbers of white pandalid shrimp, legs and viscera also white colour
0-25m	- marine life not very abundant - few rock crab, 3 lithodes crabs (Rhinolithodes), *Psolus*

Very little change in marine life and sediment from base of cliff to a depth of 70m.

PISCES IV DIVE RECORD

Location: Mouth of Bute Inlet
(opposite Fawn Point)

Date: 28 August 1976

Dive No.: 469 (Fig. 39)

Observer: D. DeMill

Position:	Start	Finish
	50°29.50'N	50°29.50'N
	125°05.50'N	125°06.30'W

Depth: 400m

OBSERVATIONS:

Surface water greenish but visibility good.
Large flocculated clumps in water.

Zooplankton - rich. Large amount of detritus, some euphausids, several large 2-tailed barrel-shaped tunicates (?), several large ctenophores, some amphipods.

Several small and a few larger squid, several herring, one ratfish.

Bottom - met cliff at 400m.

At first steep sediment-covered slope. Sediment of grey tailings-like, many *Munida*. Steeper slopes to overhangs - smooth granite faces. At 300m some large rocks, coarse sand and/or shell fragments.

Biota - deeper, some rockfish, brachiopods (?), some mostly sediment covered sponges, *Munida* everywhere, many shrimp (some sidestripes), 1 or 2 prawns.

Shallower - large cloud sponges (esp. 150 - 75 cm), some small-cushion stars, 1 decorator crab, 1 large yellow cush. star, several poster-type and similar anemones, abundant Munida, Mysid(?), swarms, some *Stylasterias forreri*, pink rockfish, 1 red snapper-like (copper-red) long-jawed rockfish, some pink pricklebacks, many shrimps, some prawns.

PISCES IV DIVE RECORD

Location: Strait of Georgia (off Texada Mine)

Date: 31 August 1976

Dive No.: 473 (Track 3) (Fig. 39)

Observer: G. Packman

Position:	Start	Finish
	$49^{\circ}41.28'$N	$49^{\circ}41.33'$N
	$124^{\circ}33.92'$W	$124^{\circ}32.72'$W

Depth: 200m

Watercolumn

- Thick phytoplankton and below that zooplankton, visibility clearing somewhat at approximately 150m.
- The water column was clouded in tailings from 85m to the bottom at the inshore end of the dive.

Bottom Characteristics

- Mud bottom with 4m visibility
- Lots of infaunal holes
- At the upper end of the track tailings began to be noticed in the sediment
- The beginning point of this was imperceptible and observations of the extent of tailings deposition close to the mine was precluded by the almost total loss of visibility from tailings in the water.

Faunal Description

- The fauna encountered was typical of the Strait of Georgia.
- On the soft mud bottom numerous infaunal holes were observed, from the burrowing activities of Polychaetes, Bivalves, Holothurians, Echiurans and Sipunculids.
- Pink shrimp (Pandalus borealis) and prawns (Pandalus platyceros) were present although not in great numbers.
- Four Gadiformes (probably Theragra chalcogramma), a few sole (Pleuronectidae) of varying types and an eelpout (Zoarcidae) were observed.

- Scattered rocks were discovered providing habitats for calcareous, tubiculous polychaetes, sea anemones (Metridium senile) and various types of rockfish (Scorpaenidae) including the quillback rockfish (Sebastes maliger) and Pacific Ocean Perch (Sebastes alutus).
- the ratfish Hydrolagos colliei was observed a number of times throughout the dive
- frequent small bathypelagic fish (possibly of the family Bathylagidea) as well as the bathypelagic shrimp Pasiphea pacifica were observed.

SUMMARY

The beginning point of tailings buildup was difficult to differentiate however at the upper end of the dive tailings deposition was very apparent as a coarse grey sediment. Animals such as Pandalus borealis and P. platyceros were still apparent when the dive was terminated due to lack of visibility. However it would seem that these animals could not extend much further inshore in the face of the tailings being discharged.

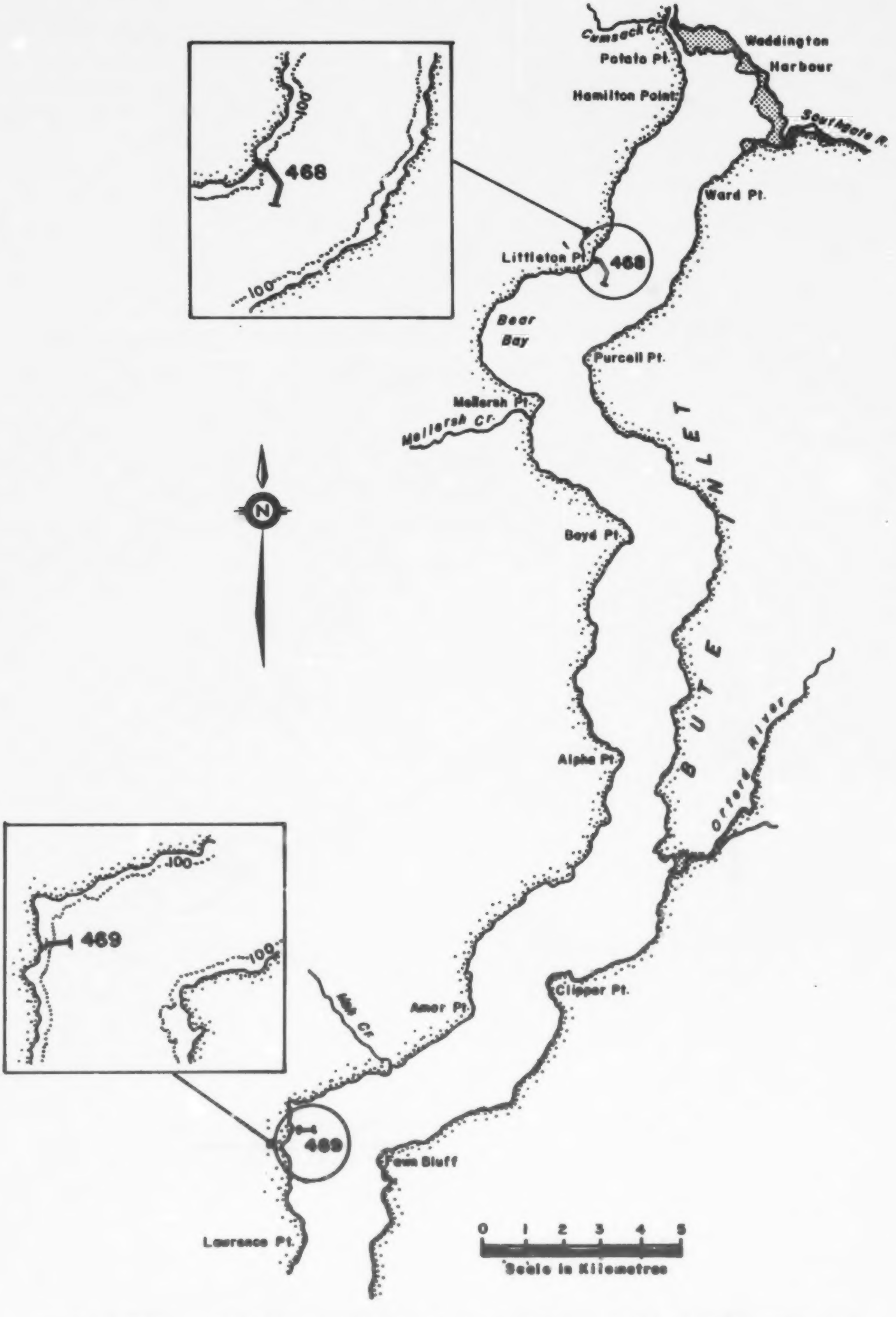
Cumsack Cr.
Waddington
Harbour
Potato Pt.
Hamilton Point
Southgate R.
Ward Pt.
Littleton Pt.
468
100
Bear
Bay
Purcell Pt.
Mellersh Pt.
Mellersh Cr.
N
BUTE INLET
Boyd Pt.
Alpha Pt.
Orford River
100
469
Cr.
Amor Pt.
Clipper Pt.
Fawn Bluff
Laurence Pt.
0
1
2
3
4
5
Scale in Kilometres

FIG. 39 PISCES DIVE TRACKS, BUTE INLET (1976).

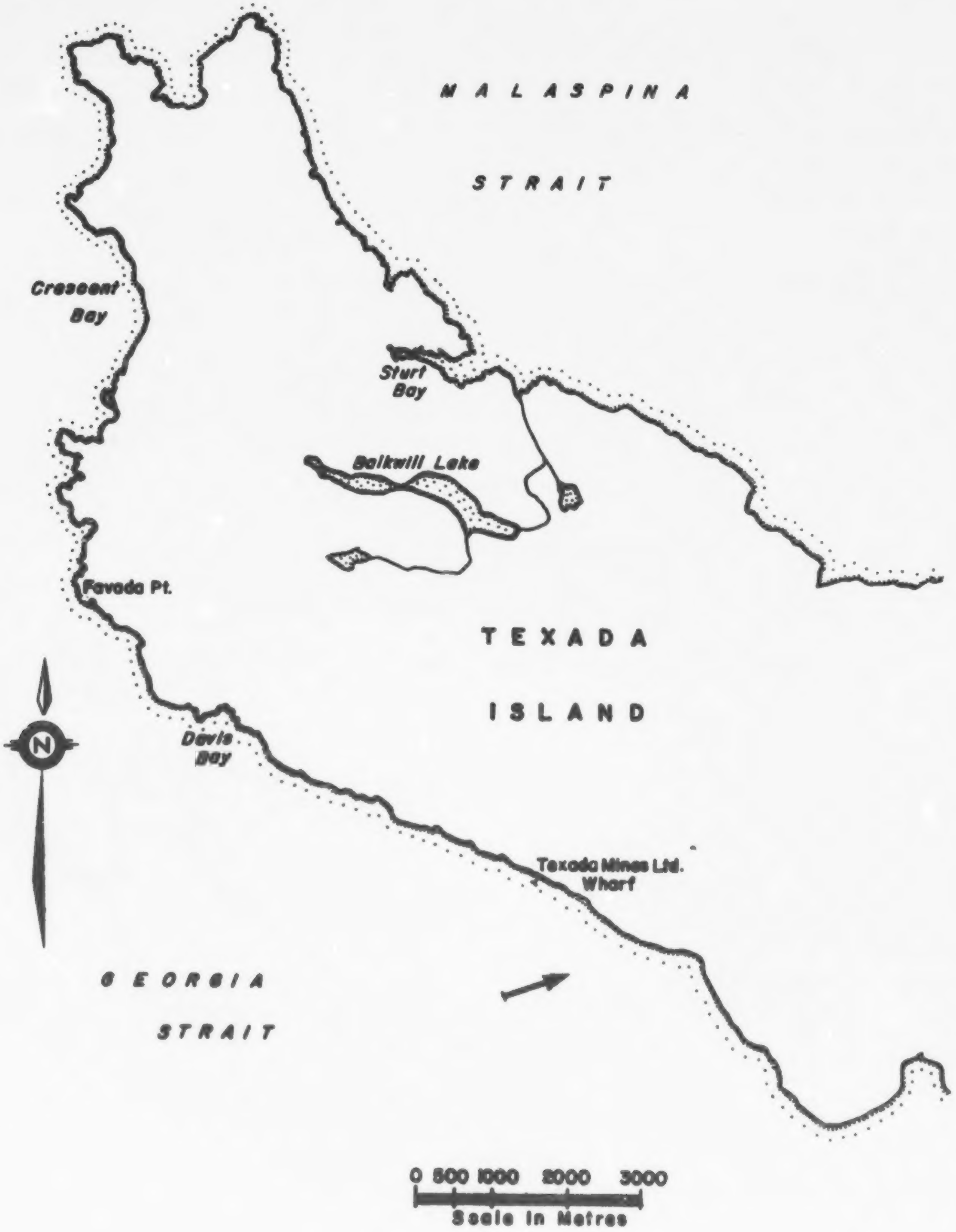
MALASPINA
STRAIT
Crescent Bay
Sturt Bay
Balkwill Lake
Favada Pt.
TEXADA
ISLAND
N
Davis Bay
Texada Mines Ltd. Wharf
GEORGIA
STRAIT
0 500 1000 2000 3000
Scale in Metres

FIG. 40 PISCES DIVE TRACK, OFF TEXADA MINE (1976).

PISCES IV DIVE RECORD

Location: Kitimat Arm (near smelter)

Date: 21 October 1976

Dive No.: 514 (Track 1) (Fig. 41)

Observers: G. Packman, N. Holman, R. Hoos

Position:

Start	Turn	Finish
53°57.60'N	53°57.76'N	53°58.05'N
128°41.30'W	128°41.02'W	128°41.86'W

Depth: 180m

Note: No report available.

PISCES IV DIVE RECORD

Location: Kitimat Arm (near smelter) Date: 21 October 1976

Dive No.: 515 (Track 2) (Fig. 41)

Observers:

Position:	Start	Turn	Turn	Turn	Turn	Finish
	53°59.25'N	53°59.35'N	53°59.27'N	53°59.22'N	53°59.28'N	53°59.19'N
	128°41.25'W	128°41.05'W	128°40.81'W	128°40.61'W	128°40.62'W	128°40.70'W

Depth: 128m

Note: No report available.

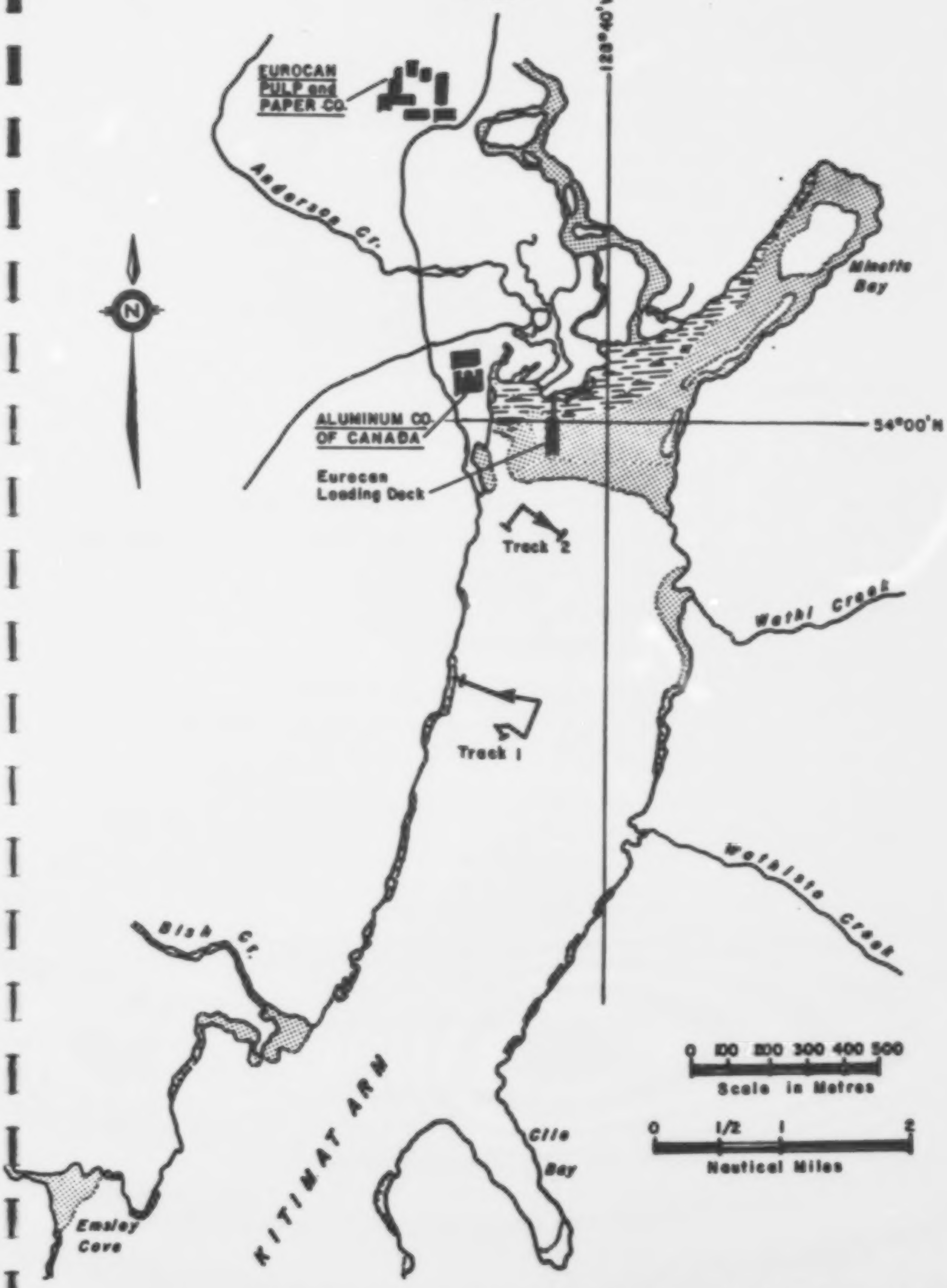
128°40'W
EUROCAN PULP and PAPER CO.
Anderson Cr.
Minette Bay
N
ALUMINUM CO. OF CANADA
54°00'N
Eurocan Loading Deck
Track 2
Wathl Creek
Track 1
Wathlsto Creek
Bish Cr.
KITIMAT ARM
Clio Bay
Emsley Cove
0 100 200 300 400 500
Scale in Metres
0 1/2 1 2
Nautical Miles

FIG. 41 **PISCES IV - DIVE TRACKS**, KITIMAT SMELTER (1976)

PISCES IV DIVE RECORD

Location: Hastings Arm

Date: 23 October 1976

Dive No.: 518 (Fig. 42)

Observers: D. Goyette, H. Nelson

Position:	Start	Turn	Finish
	55°29.45'N	55°29.13'N	55°23.09'N
	129°45.70'N	129°45.23'W	123°44.70'W

Depth: 300m

OBSERVATIONS:

Surface	- visibility - beyond range of the lights - White suspended particles throughout water column. No zooplankton in upper 60m.
60m	- Small euphausids (*E. pacifica*?) - few - Ctenophore (occasional).
100m	- Appearance of *Bolinopsis* (ctenophore) - Zooplankton increasing; euphausids, occasional amphipod (hyperid).
125m	- Siphonaphore
150m	- Smelt (few) - Amphipod (few)
175m	- Smelt (numbers increasing) - Occasional pelagic shrimp (*Pasiphaea* sp.)
200m	- Numbers of amphipods increasing. - Ctenophores abundant - *Boroë* and *Bolinopsis*.
260m	- Bottom (OS15). - Visibility greater than 4m. - Sediment soft, light brown colour. Sediment beneath surface dark, bluish grey colour. - Tidal currents present, velocity sufficient to require small fish (*Nectoliparis* sp.) to swim actively to maintain position on the bottom.

- Course heading 160° against flood tide.
- Burrows (numerous).

  Dominant organisms - large hermit crabs occupying *Neptunea* shells, small hermit crabs, and shrimps, sidestripe (*Pandalopsis dispar*) very abundant, pink shrimp (*P. borealis*) - very common.
- Occasional pollock (*Theragra chalcogramma*).
- Eelpout (few).
- Small white sea pens (numerous).
- Unidentified (leech like) worm; dorso-ventrally flattened pointed anterior, dark brown - swims in undulations (common).
- Small octopus (7).
- Fish less abundant than previous dives, mostly eelpouts, occasional pollock, one sole, occasional sturgeon poacher (*Agonus acipenserinus*), no ratfish or dogfish observed. These were commonly seen during submersible dives in other areas.
- *Nectoliparis* - very common.
- Shrimp appear to occur in groups and in considerable numbers compared to Knight Inlet (pilot observation) and Howe Sound. Bottom free of wood debris.

290m - Alaska king crab (2) - *Paralithodes* sp.

300m - (1018) Altered course to 060° - toward shore

- Alaska king crab (1).

265m - @ 1035.

- sloping, mud bottom.

250m - Alaska king crab (3).

240m - Numbers of pink shrimps increasing.

- Side stripes - still abundant. Shrimps approximately 8-10/m^{2} occurring in groups.

225m - (1035) Numerous eelpouts.

200m	- (1100 hrs.) Base of steep cliff, rock face very smooth, covered by thin layer of sediment. Surface covered with brachiopods, occasional pink sea urchin (S. *paligus*) sea cucumber (similar to *Parastichopus*) common - spines long and fleshy.
160m	- *Munida* (few).
150m	-(1116) Marine life on rock cliff largely brachiopods, few *Neptunea*, sidestripe (no prawns observed), few basketstars (*Gorgonocephalus*). - Numbers *Munida* increasing.
125m	- (1126) Occasional crinoid - *Florometra*, cushion star *Pteraster*, fewer shrimps, few rock fish.
40m	- (1152) Brachiopids continue dominance. - Entering zone of calcarious tube worms, occasional *Psolus* (creeping cucumber). - Visibility with ambient light in excess of 18m.
25m	- (1156) Encrusting algae. - Occasional cloud sponge.

SUMMARY

Dominant macroinvertebrate species - larger hermit crab and pandalid shrimp (*Pandalopsis dispar*)

Six Alaska king crab observed between 250 and 300m.
Very few fish observed - mostly eelpouts. No dogfish or ratfish, (commonly observed during other dives), seen in Hastings Arm.

Few rock fish inshore, 1 sole.

Dominant invertebrate on rock face - brachiopods - similar to most dives.
Very little change in marine life on rock face between 50 and 200m.

PISCES IV DIVE RECORD

Location: Hastings Arm　　Date: 23 October 1976

Dive No.: 519 (Fig. 42)

Observers: D. Goyette, D. Sullivan

Position:	Start	Finish
	55°34.00'N	55°34.01'N
	123°47.57'W	123°47.13'W

Depth: 270m

OBSERVATIONS:

	- Visibility similar to 518. - Plankton absent 0-50m. Numbers increased below 100m.
100m	- Amphipod, ctenophore.
170m	- Smelt.
225m	- Eelpout course OEO°.
270m	- (1335) Bottom, course 020°. Sediment similar to 518. Grey coloured sediment beneath surface seen at 518 not observed. - Burrows more numerous than 518. - Eelpout more numerous than 518 but not abundant. - Fewer shrimp than dive 518, sparse, occasional sidestripes. - Alaska king crab (1). - Small octopus (5). Changed course to 090° (1411) toward shore, bottom sloping.
250m	- (1417) - Hermit crab (few). - Sidestripe (occasional). - Tanner crab (1).
200m	- (1455) - Numbers of sidestripe increasing and larger size. - Numerous burrows.

- Numerous tadpole-like fish - light brown, transparent outer covering, larger head.
- Numbers of pink shrimps increasing.
- Alaska king crab (1).
- Visibility - beyond range of lights.

150m - Shrimp more abundant than 270m. 3-4 sidestripe and pink shrimp $/m^2$.

125m - (1455) Contact with rock cliff, marine life similar to 518. Occasional Munida, rockfish, pink sea urchin, pectin, flounder.

100m - (1505) Dive terminated due to leak in ballast system.

SUMMARY

Generally similar to dive 518 except fewer shrimps and slightly greater numbers of fish (eelpouts). Numbers of shrimps (sidestripe, pinks) increased slightly inshore. No dogfish or ratfish and only few flatfish observed compared to Howe Sound, Bute Inlet etc. Two Alaska king crab observed. Fewer hermit crab burrowing anemones normally seen in areas not observed.

PISCES IV DIVE RECORD

Location: Alice Arm (head) **Date:** 24 October 1976

Dive No.: 520 (Tracks 1 and 2) (Fig. 42)

Observers: D. Goyette, J. Littlepage

Position:	Start	Turn	Turn	Turn	Finish
Track 1	55°27.10'N 129°29.80'W	55°27.10'N 129°29.71'W	55°27.12'N 129°29.58'W	55°27.12'N 129°29.32'W	55°27.24'N 129°29.16'W
Track 2	55°27.85'N 129°29.35'W				55°28.05'N 129°29.40'W

Depth: 150m

OBSERVATIONS:

Greater number of zooplankton (75m) than Hastings Arm. Visibility similar except near the bottom. Greater number of jellyfish beginning at 95m. *Bolinopsis*, *Boroë* (ctenophore) also abundant.

150m

- (0916) Visibility - 3m, sediment light brown surface, lighter sediment beneath surface. Soft and silty, easily disturbed, course heading 070°.
- Small Alaska king crab (1).
- Fewer shrimps observed than 518 and 519.
- (*Pandulus borealis*).
- No sidestripes observed (start of dive).

150m

- (0930)
- Numerous basket stars (*Gorgonocephalus*).
- Clumps of Fucus sp. common throughout dive.
- Anemones (occasional) white base, pink tentacles.
- Fewer burrows than 518.
- Tanner crab (occasional).
- Tadpole snail fish (brown) numerous.
- Sea whips (occasional) - 5 cm. diameter, 2m in length, white.
- Eelpout (grey, mottled colour similar to a ling cod colouration).

- Small skate (1).
- Alaska king crab (1).
- Occasional shrimps, few sidestripes.

125m - (0946) Continued on course 070°. Bottom gradual upward slope.
- Sole (occasional).
- Large sea ships very numerous.
- Basket stars (very common).
- Contact with tailings delta - surface colour similar to earlier portion of dive, obvious reduction in burrowing activity, surface smooth and compact, slope steeper.
- Numerous sea ships at base of delta.

100m - (0957) Contact with rock cliff.
- Many basket stars.
- Numerous sea whips.
- Cloud sponge (numerous).
- Boot sponge (few).
- Eelpouts (occasional).
- No shrimps or hermit crabs observed.

90m - (1011) Changed course to 030°.

70m - (1019) Changed course to 070°.
- Flat fish more abundant than 518.

60m - (1022) Changed course to 170°.
- Continue to follow tailings delta.
- Obvious reduction in marine life.
- Shrimp absent.
- Large pink/white sea anemone - numerous.

30m - (1035) Shrimps absent.
- Visibility greater than 4m.
- Sea whips (occasional).
- Sediment grey in colour around burrows.
- *Cancer magister* (1) - 1st sighting since start of dives
- Course 020°.

20m - (1046) Surfaced.

DIVE 520 (Track 2)

- 1105 hrs.
- Sediment characteristics similar to early portion of 520 (1). Fewer burrows than Hastings Arm.
- Tanner crab (numerous).
- Small pandelid shrimp (few) - pink and humpback, hermit crab, Hyas (occasional).
- Flat fish (common).
- Nudibranch (few).
- Current and sediment dispersion - negligible.

100m - (1149) End of dive.

SUMMARY

Bottom sediment with exception of tailings delta similar to Hastings Arm.
Fewer burrows, fewer shrimps - mostly pinks, fewer larger hermit crabs.
Greater number of flat fish compared to Hastings Arm.
Basket stars, larger sea whips, Tanners crab (Chionoecetes) - very common.
Tailings delta-noticeable reduction in burrowing activity. Surface smooth and compact.
Bottom currents minimal during dives in Alice Arm.

PISCES IV DIVE RECORD

Location: Alice Arm (centre) Date: 24 October 1976

Dive No.: 521 (Fig. 42)

Observers: D. Goyette, J. Littlepage

Position:

Start	Turn	Finish
55°27.08'N	55°27.08'N	55°26.80'N
129°35.78'W	129°35.78'W	129°36.18'W

Depth: 380m

OBSERVATIONS:

Descent similar to dive 520 - fewer numbers of small jelly fish. *Boroë* very common below 125m.

380m
- (1520) Bottom, course 070°.
- Sediment light brown, soft. Sediment surrounding burrows light brown colour compared to light grey observed at head of inlet.
- Visibility murky,
- Small hermit crabs (occasional).
- Alaska king crab (2).
- Shrimp (mostly pinks, few sidestripe), considerably fewer than Hastings Arm but more abundant than head of Alice Arm.
- Prawn (occasional).
- Eelpouts - common.
- Small skate.
- Pollock (common).
- Burrowing anemones commonly seen in other regions noticeably absent, also ratfish and dogfish absent.

380m
- (1540) Changed course to 180°.
- Gradual upward slope.
- Shrimp occurring in groups in large numbers (20/m^2) (pinks and sidestripe) other areas shrimp are sparse.
- Tanner crab (occasional).

340m	- (1620) Mud slope. - Contact with slide area covered by rock fragments, boulders, shell (cockle) debris - steep slope.
315m	- (1630) Contact base of rock cliff. - Brachiopod (many). - Rock covered with thin layer of sediment. - Hermit crab, pectins, pink sea urchins (*S. paligus*) (few). - Pteraster (occasional). - Fan coral (*Paragorgia* sp.) few.
250m	- (1639) Large Alaska king crab - observed on rock ledge.
200m	- (1645) Crinoid (*Florometra*) few. - *Pteraster* - common. - *Munida* - absent. - Shrimp (*pandalid*) numerous on rock ledges covered with sediment.
150m	- (1658)
135m	- (1700) *Munida* (occasional). - Cloud sponges. - Larger prawns (few) - prawns do not appear to be very abundant in either Alice Arm or Hastings Arm. - Sea anemones (pink/white) common.
75m	- (1705)
25m	- (1710) Surfaced.

SUMMARY

Shrimp fewer than Hastings Arm but greater than head of Alice Arm. Eelpouts very common.

Three Alaska king crab.

Rock face - greater variety of marine life than Hastings Arm - fan coral pink urchin, *Pteraster* (cushion star), shrimps common on ledges covered by sediment.

Cloud sponge common, occasional solaster, numerous brachiopods. Type of marine life varied little between 30 and 280m.

Visibility - lower than dives in Alice and Hastings Arm.

Cancer magister sparse.

PISCES IV DIVE RECORD

Location: Alice Arm (mouth) Date: 25 October 1976

Dive No.: 522 (Fig. 42)

Observers: D. Goyette, H. Nelson

Position:

Start	Turn	Turn	Turn	Finish
55°24.71'N	55°24.64'N	55°24.88'N	55°25.14'N	55°25.30'N
129°40.76'W	129°40.60'W	129°40.65'W	129°40.95'W	129°40.72'W

Depth: 85m

OBSERVATIONS:

visibility - clear.

Detritus, no zooplankton observed until reaching bottom.

85m
- (0903) Bottom visibility 4.5m.
- Currents negligible.
- Macroinvertebrates numerous and diverse - abundance similar to Hastings Arm.
- Basket stars (Gorgonocephalus) very numerous. Adults often surrounded by numerous juveniles.
- Crossaster - few.
- Hermit crabs (large) - abundant.
- Tanner crab (numerous).
- Larger sea whips (common).
- Flounder (common), Pollock (common).
- Shrimp - few pinks, no sidestripes.
- Humpback shrimp (common compared to other dives).
- Skate (1).
- Eelpout (common).

75m
- (0930) Increase in number of shrimp - mostly P. borealis with few sidestripes and humpbacks - shrimp occurring in groups.

60m
- (0935) Alaska king crab (4).
- Basket stars, sea whips - common.
- 16 Alaska king crab - grouped together, captured smaller king crab.

- Carapacewidth 19.05 cm, legs 1.31m tip to tip
- *Parasticopus* - like sea cucumber common.
- Flatfish, eelpout - numerous.
- One approx. 2 kg. salmon observed.

(1005) Course - due north 75m.

60m - (1026) Slope, bottom changing to gravel.
- Numerous small white sea urchins associated with gravel bottom.
- Tanner crab.
- Solitary corals (on rocky areas).
- Humpback shrimps - numerous.
- *Parastichopus* - like sea cucumber - common.
- Flounder, sculpin - few.
- No shrimps seen on gravel.

60m - (1035) Contact with rock cliff.
- Few brachiopod.
- many shrimp - on rock face and ledges.

Pteraster, *Crossaster*, *Patria* (orange), *Henricia*, *Mediaster* starfish - common.
- Cloud sponge.
- Rock relatively sediment free.

10m - (1048) Forced to surface due to strong lateral current.

SUMMARY

Compared to other dives - area showed a greater diversity of macroinvertebrates - greatest abundance of Alaska king crab.

PISCES IV DIVE RECORD

Location: Observatory Inlet   Date: 25 October 1976

Dive No.: 523 (Fig. 42)

Observers: D. Goyette, D. Sullivan

Position:	Start	Turn	Turn	Turn	Finish
	55°21.60'N	55°21.65'N	55°21.68'N	55°21.48'N	55°21.51'N
	129°45.76'W	129°45.00'W	129°44.80'W	129°44.66'W	129°44.46'W

Depth: 210m

OBSERVATIONS:

Surface visibility - clear. Detritus concentration similar to previous dives.

90m	- Appearance of ctenophores Bolinopsis. - Occasional euphausid small fish, chaetognaths.
125m	- Numbers of ctenophores increased. - Numerous hyperid amphipods. - Numerous ctenophores.
150m	- Numerous smelt.
200m	- Visibility decreasing.
210m	- (1320) Bottom - soft brown mud, occasional burrow. - approximately $1.5m^2$ light grey underneath. - Visibility approx. 3m. - Course 100°. - Numerous domeshaped anemones observed - colours varied, pink, white to deep red. - Small sea pens (white) common. - Numerous small shrimp (P. borealis). - Few sidestripes. - Sculpin (1). - Eelpouts (few). - Tanner crab (few). - Small squid (8). - Flounder (few). - Hyas - common.

	- (1413) Changed course to 120°.
200m	- (1429) Changed course to 150°. - Bottom sloping towards shore. - Shrimps 6-8/m^2 occurring in groups. - Conc. of shrimp similar to Alice Arm occasionally clustered in groups of 15-20. - Numerous burrows. - Brittle stars - exceptionally numerous, covered the entire bottom, arm to arm throughout most of the dive area.
200m	- (1425) Bottom becoming steeper (about 45°). - Brittle stars - dominant. - Shrimp (P. borealis) - numerous. - Occasional sidestripe.
180m	- (1435) Rock outcroping.
175m	- Return to mud bottom. - Larger numbers brittle stars, P. borealis, (common). - Small octopus. - Pteraster.
145M	- (1455)
125m	- (1500) Bottom covered by brittle stars. - Shrimp (occasional). - Tanner crab. - Parasite seen on king crab observed free living on bottom debris. - Munida (occasional). - Humpback shrimp (few). - Tubeworms. - Cabazon.
100m	- (1507) Gravel bottom, occasional boulder. - Crinoid (few) - Florometra.
95m	- (1510) Contact with base of cliff. - Brachiopod, brittle stars, Parasticopus - like sea cucumber.

- Light cover of sediment over rocks.
- Crinoids, Pteraster - common.
- Pycnopodia (few).
- Bottom varied from silt to rock and coarse sand to solid rock.
- Cloud sponge, crinoids. Munida, and tubeworms - common on rock face, occasional flounder.

20m - Rock surface free from sediment.
- Left bottom at 1530.

SUMMARY

Shrimp abundant similar to Alice Arm - mostly pinks with the occasional sidestripe and humpback. Brittle stars - most dominant species throughout dive. Eelpout, flatfish, pollock - common. Flatfish less abundant than head of Alice Arm. Bottom ranged from fine silt to gravel/silt to coarse sand/boulder to clean rock from centre channel to shoreline.

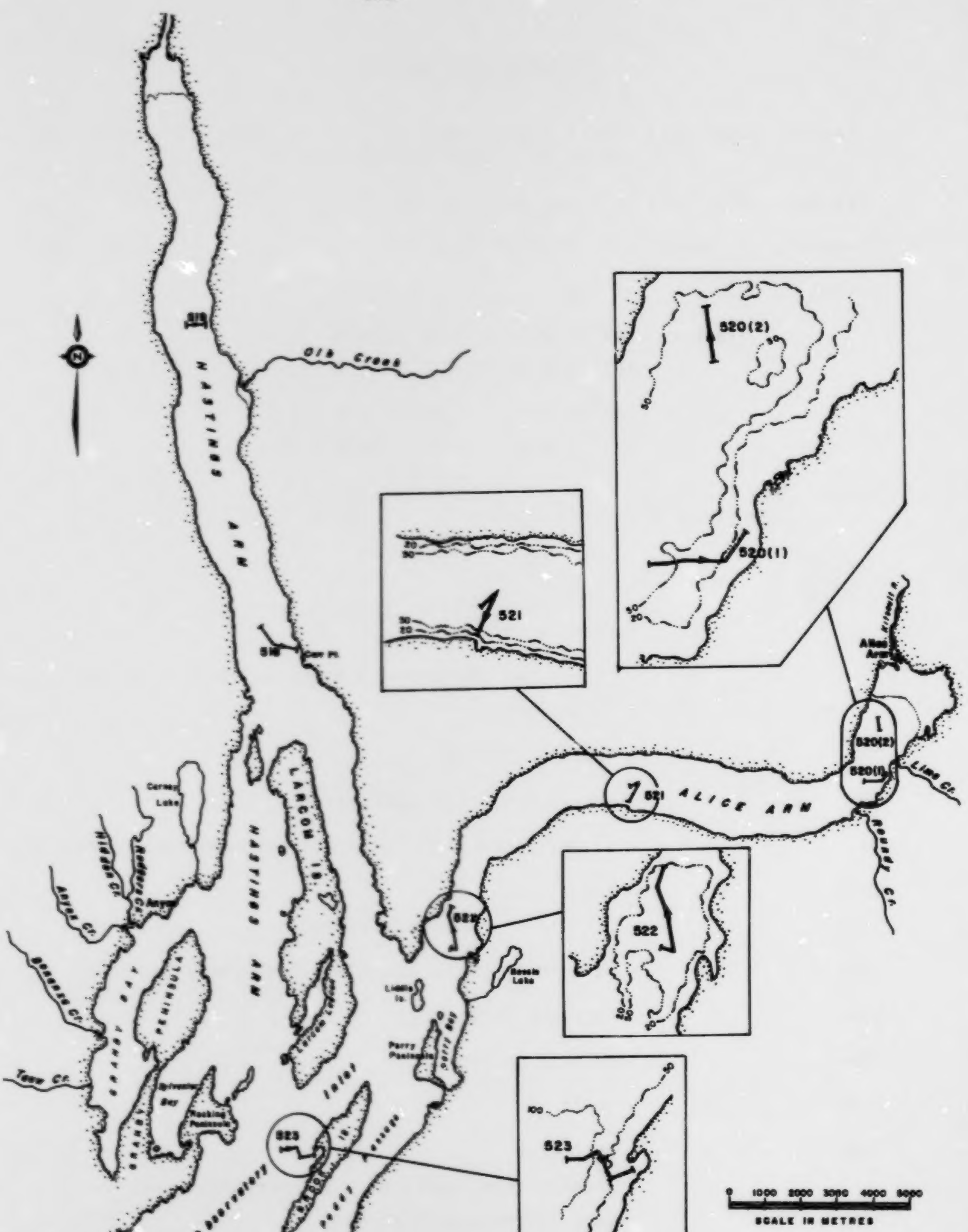
N
519
Olh Creek
HASTINGS ARM
518
Larcom Is.
HASTINGS ARM
Carney Lake
Hiddon Cr.
Anyox
Anyox Cr.
Granby Bay
Peninsula
Tauw Cr.
Granby
Sylvester Bay
Peninsula
Observatory Inlet
Inlet
523
Perry Peninsula
Perry Bay
Liddle Is.
Bonanza Lake
522
521
ALICE ARM
520(2)
520(1)
Alice Arm
Kitsault R.
Lime Cr.
Roundy Cr.
20
50
521
520(2)
50
50
50
20
520(1)
522
20
50
20
100
50
523
0
1000
2000
3000
4000
5000
SCALE IN METRES

FIG. 42 PISCES DIVE TRACKS - ALICE ARM, HASTINGS ARM, AND OBSERVATORY INLET (1976).

PISCES IV DIVE RECORD

Location: Howe Sound (Daisy Creek, Track 1) Date: 20 April 1978
(North of Britannia Mine Track 2)

Dive No.: 653 (Tracks 1 and 2) (Fig. 43)

Observers: D. Goyette, D. Brothers

Position:

	Start	Finish
Track 1	49°36.36'N	49°36.50'N
	123°13.48'W	123°12.98'W
Track 2	49°38.06'N	49°38.13'N
	123°13.29'W	123°12.78'W

Depth: 272m (Track 1)
242m (Track 2)

Track 1

	Surface - murky.
3.0m 6.6.m	- floccs and strings of diatoms abundant - strings up to 15 cm long.
20m	- few zooplankton.
52m	- detritus, little zooplankton.
80m	- slight increase in zooplankton, occasional euphausids.
100m	- smelt
115m	- occasional Hyperid (amphipod).
160m	- occasional smelt, one ctenophore (very few seen).
180m	- increase in smelt
190m	- pelagic shrimp
202m	- smelt
272m	- on bottom - smooth, thin layers of silt over gray clay. - some spirontocarid shrimp. - few Hake like fish - silver lateral line, gray colour, mottled, thin body, no sign of dorsal fin. - occasional Munida sp.

	- course 020° mostly spirontocarid shrimp. - occasional eelpout - absence of craters commonly seen on the bottom - occasional Hake like fish, ratfish, eel pouts.
250m	- smooth bottom - occasional Munida sp. - no other pandalid shrimp seen to this point except for 2 sidestripe shrimp. - eelpouts, light brown, black fins.
225m and up	- occasional Colus sp. - steep ridge, vertical face, no sign of rock - very rough bottom lumps, ridges - course in shore 120° - steep slope, rough bottom
180m	- followed steep ridge perpendicular to shore, flat top width of Pisces - fell off sharply on either side - face almost vertical
157m	- several prawns - lost ridges at pinnacle - several small cuttlefish - Spirontocaris sp. and Pandalid shrimp
140m	- ridge - ratfish, Colus - a number of large craters, increase in numbers of Pandalid shrimp
129m	- occasional Munida
120m	- Prawn, pin anemones (small)
102m	- rock cliff, silted - occasional exposed rock - areas generally covered by brachiopods, small anemones - sponges not present if slight layer of silt. Large Metridium, appear to tolerate thicker layers of silt.

	- numerous small Munida - burrowing anemones on silt ledges.
87m	- steep, smooth rock face covered with sediment - numerous Perch (small) - one Tanner crab
58m	- barren sediment - numerous sessile invertebrates on sediment free areas regardless of how small the area - generally sponges, small anemones and brachiopods - small sea whips - headed for surface
Track 2	
2.4m	- surface visibility - murky
15m - 22m	- diatom strings
72m	- decreasing visibility, murky layers
80m	- increasing visibility
242m	- bottom - numerous small *Munida* sp. - bottom similar in appearance to that of Track 1. - visibility 4.5m - numerous spirontocarid shrimp, *Munida* very numerous, flatfish, eelpouts - flat bottom, no evidence of large craters, occasional log and wood debris. Munida very numerous - few gastropods - *Colus*? - on wood debris - occasional eelpouts, mostly Munida (small) and *Spirontocaris* sp.
243m	- no starfish seen on both Track 1 (morning) and Track 2 (evening) dives - ratfish - level bottom
293m	- base of cliff - covered with thick layer of silt

	- worm castings, eelpouts - increasing number of burrows - contacted another ridge
196m	- mostly spirontocarid shrimp - occasional pink shrimp - occasional side stripe - Tanner crab - sturgeon Poacher
133m	- increasing numbers of prickleback and eelpouts
128m	- visibility decreasing - few Pandalids - cancer crab - large craters
89m	- still turbid - Pandalids common
100m	- side stripe
87m	- visibility 60 cm. - Tanner crab - Lemon sole
68m	- bare rock heavily silted, not as smooth as Track 1 dive. - poor visibility
40m	- rock fish
15m	- leaving bottom - large no. of *Cancer magister* near end of dive

SUMMARY

- bottom similar on both dives
- gray beneath thin layer of brown sediment
- few burrows
- fewer fish than previous dives
- mostly eelpouts and pricklebacks
- occasional sole, ratfish, dogfish
- mostly spirontoca is shrimp with numbers of Pandalids increasing inshore
- pinks and occasional sidestripe
- bottom topography consisted of a series of terraces lying parallel to the shore line and sharp ridges running perpendicular to shore.

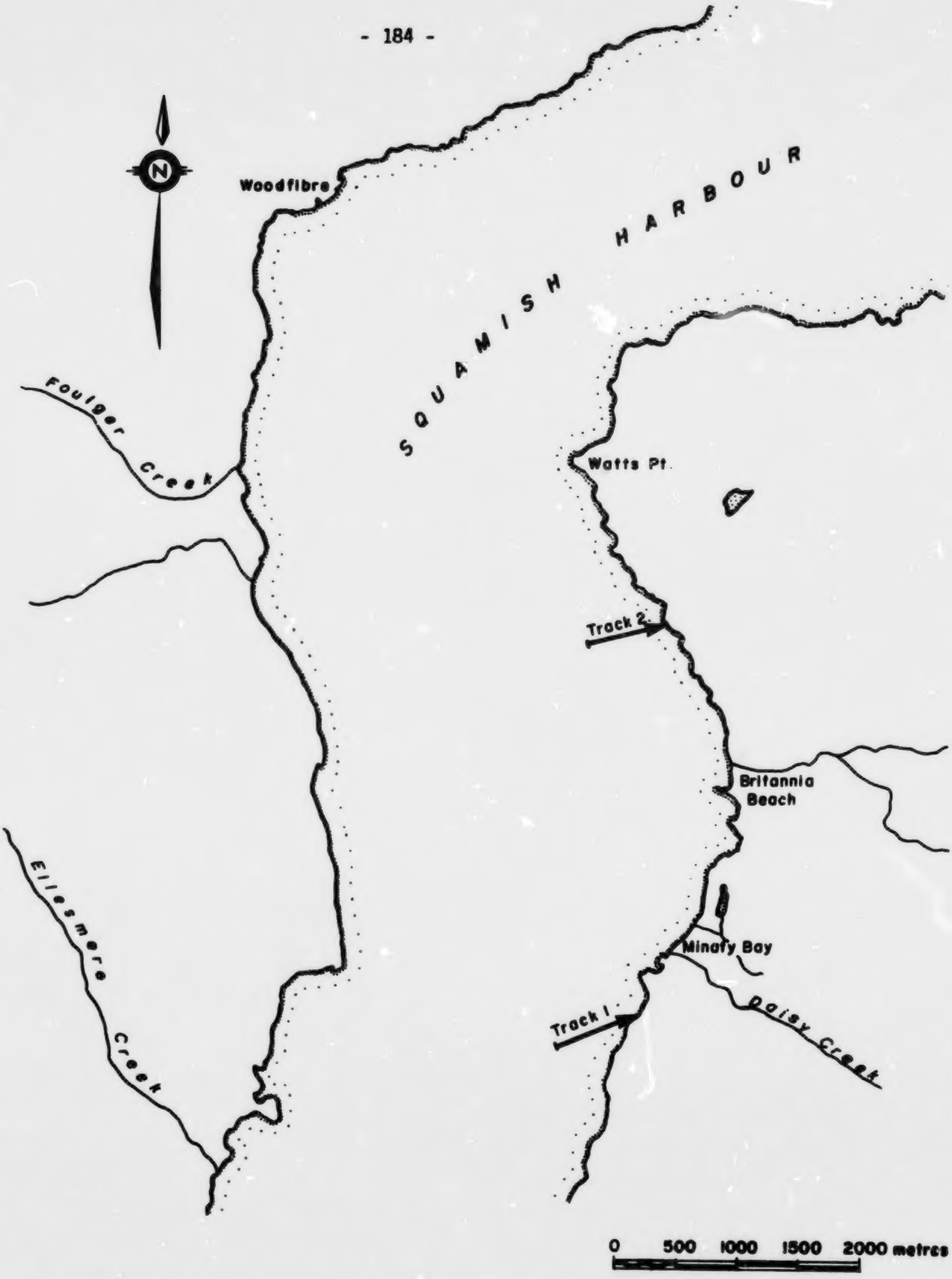
N
Woodfibre
SQUAMISH HARBOUR
Foulger Creek
Watts Pt.
Track 2
Britannia Beach
Minaty Bay
Track 1
Daisy Creek
Ellesmere Creek
0 500 1000 1500 2000 metres

FIG. 43 PISCES DIVE TRACKS, HOWE SOUND (1978).

PISCES IV DIVE RECORD

Location: Howe Sound Date: 21 April 1978

Dive No.: 654 (Fig. 44)

Observers: D. Goyette, P. Christie

Position:	Start	Turn	Turn	Turn	Turn	Finish
	49°34.08'N 123°15.50'W	49°34.02'N 123°15.85'W	49°33.75'N 123°15.92'W	49°33.58'N 123°16.00'W	49°33.34'N 123°16.10'W	49°33.16'N 123°16.22'W

Depth: 250m

250m	- bottom - visibility 9m - 12m - muddy bottom
270m	- sloping mud bottom - change course 180° to top of sill
154m	- bottom steep mud slope
45m	- forest of sea pens - slope up was not steep, therefore carry on down slope on course 180°
100m	- skiing down slope
135m	- flat bottom - batteries flat - headed for surface.

Species noted

Ambrocallistes sp. - many on slope
squat lobster - few
starfish - few
Cancer magister (6)
spider crabs - occasional
Eelpout - many
Pachycerianthus sp. - many

Stylatula elongata - many
Neptunea sp. - few on logs
Rockfish - occasional
Ratfish - few
Sole - occasional
Pandalus platyceros - numerous
Pandalus borealis - few

Also:

- Metridium senile
  Ptilosarcus gurneyi
  Colus sp.
  Pacifaea pacifica
  Hermit crabs
  Henricia sp.
  Hake
  Pollock
  Quillback Rockfish
  Dogfish

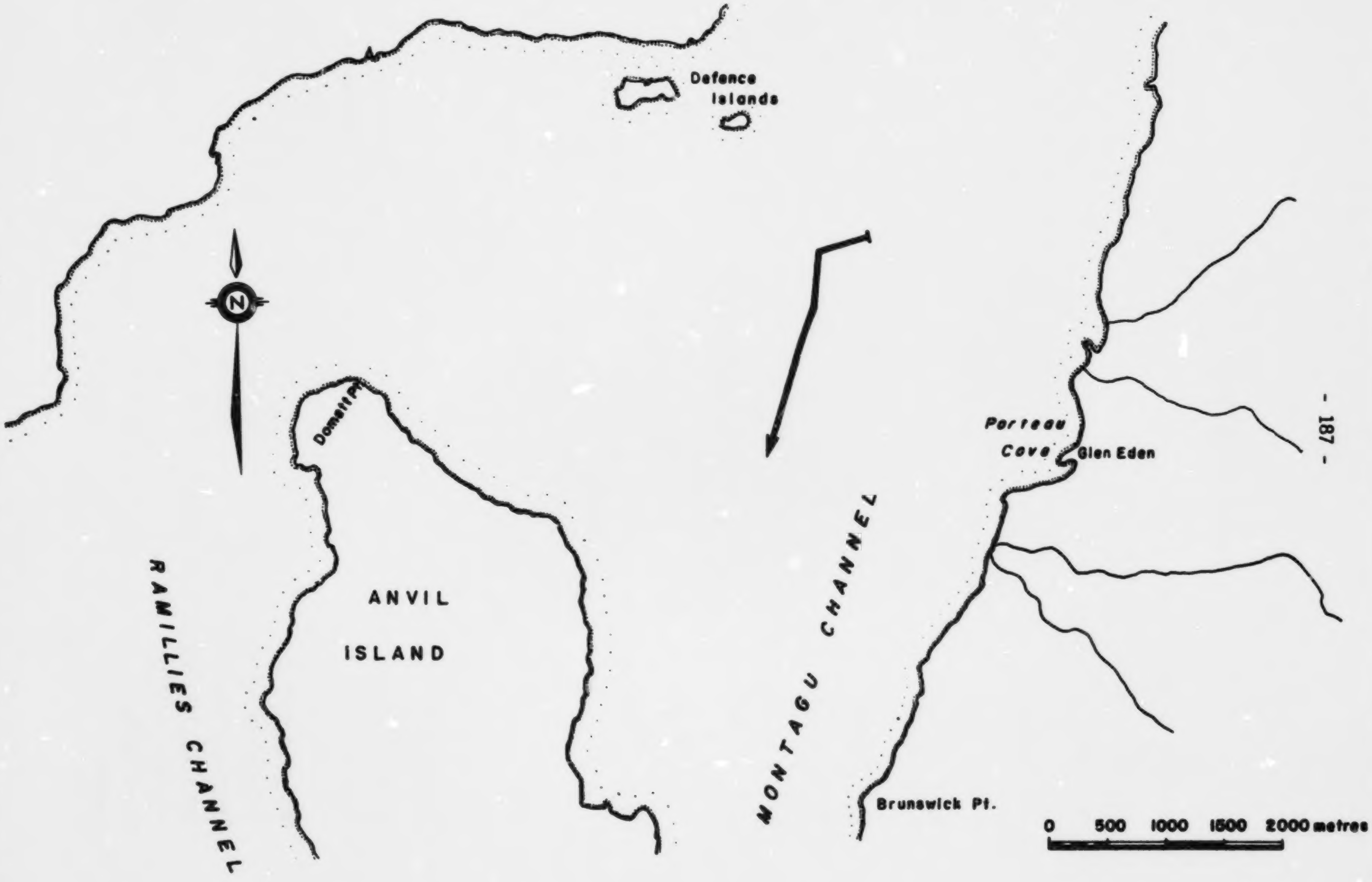
Defence
Islands
Domett Pt.
ANVIL
ISLAND
RAMILLIES CHANNEL
MONTAGU CHANNEL
Porteau
Cove
Glen Eden
Brunswick Pt.
N
0
500
1000
1500
2000 metres

FIG. 44 PISCES DIVE TRACK, HOWE SOUND (PORTEAU COVE) 1978.

PISCES IV DIVE RECORD

Location: Howe Sound — Date: 21 April 1978

Dive No.: 655 (Fig. 45)

Observers: D. Goyette, D. Sullivan

Position:

Start	Finish
49°29.60'N	49°29.35'N
123°15.55'W	123°14.95'W

Depth: 233m

OBSERVATIONS:

233m	- on bottom - mud bottom - visibility 3m - 4m - shrimp, anemones, and starfish - course 150° - change to 070° towards shore
235m	- base sloping - mud bottom - now bottom is a jungle of rocks
200m	- coming up steep, broken rock face - headed for surface

Species noted:

Aphrocallistes sp.
Rhabdocallistes sp.
Soft sponges
Metridium senile
Pachycerianthus sp.
Pandalus borealis
Pandalus platyceros
Pacifaea pacifica
Squat lobster
Crangon
Bryozoa
Terebratula
Solaster sp.
solitary Ascidian
Eelpout
Pollock
Rockfish
Ratfish
Dogfish
Sole
Tanner Crab
Pseudarcaster
Chiridota
Tunicates

PISCES IV DIVE RECORD

Location: Howe Sound Date: 22 April 1978

Dive No.: 656 (Tracks 1 and 2) (Fig. 46)

Observers: D. Goyette, R. Kussat (Track 1) R. Hoos, M. Ito (Track 2)

Position:

	Start	Finish
Track 1	49°25.38'N 123°14.80'W	49°24.68'N 123°14.50'W
Track 2	49°27.00'N 123°18.00'W	49°27.15'N 123°18.85'W

Depth: 235m (Track 1)
244m (Track 2)

Track 1

235m	- on bottom - moving off on course 150°
234m	- heading on course of 120° - bottom is basically mud - visibility 3m - 4m - lots of hills and valleys
211m	- coming up steep mud slope - not a lot of fish
180m	- still on mud slope
148m	- coming up a rock bluff
101m	- coming up a mud and rock bluff - headed for surface

Track 2

244m	- on bottom - moving off on course 255°
206m	- coming up slight mud slope
175m	- coming up a rock bluff
85m	- on a plateau

86m	- still on plateau - headed for surface

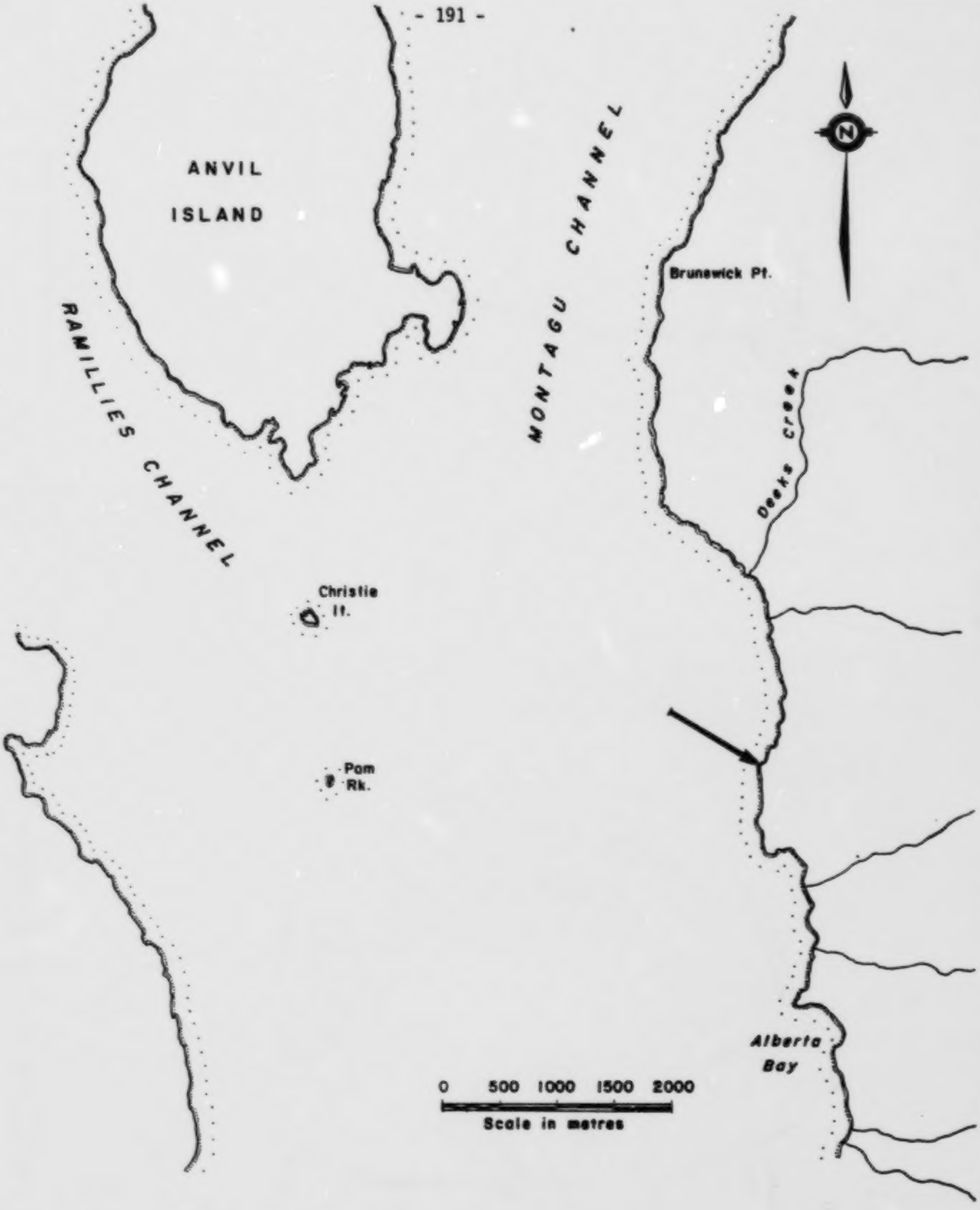
ANVIL
ISLAND
RAMILLIES CHANNEL
MONTAGU CHANNEL
Brunswick Pt.
Deeks Creek
Christie
It.
Pam
Rk.
Alberta
Bay
0 500 1000 1500 2000
Scale in metres

FIG. 45 PISCES DIVE TRACK, HOWE SOUND (1978).

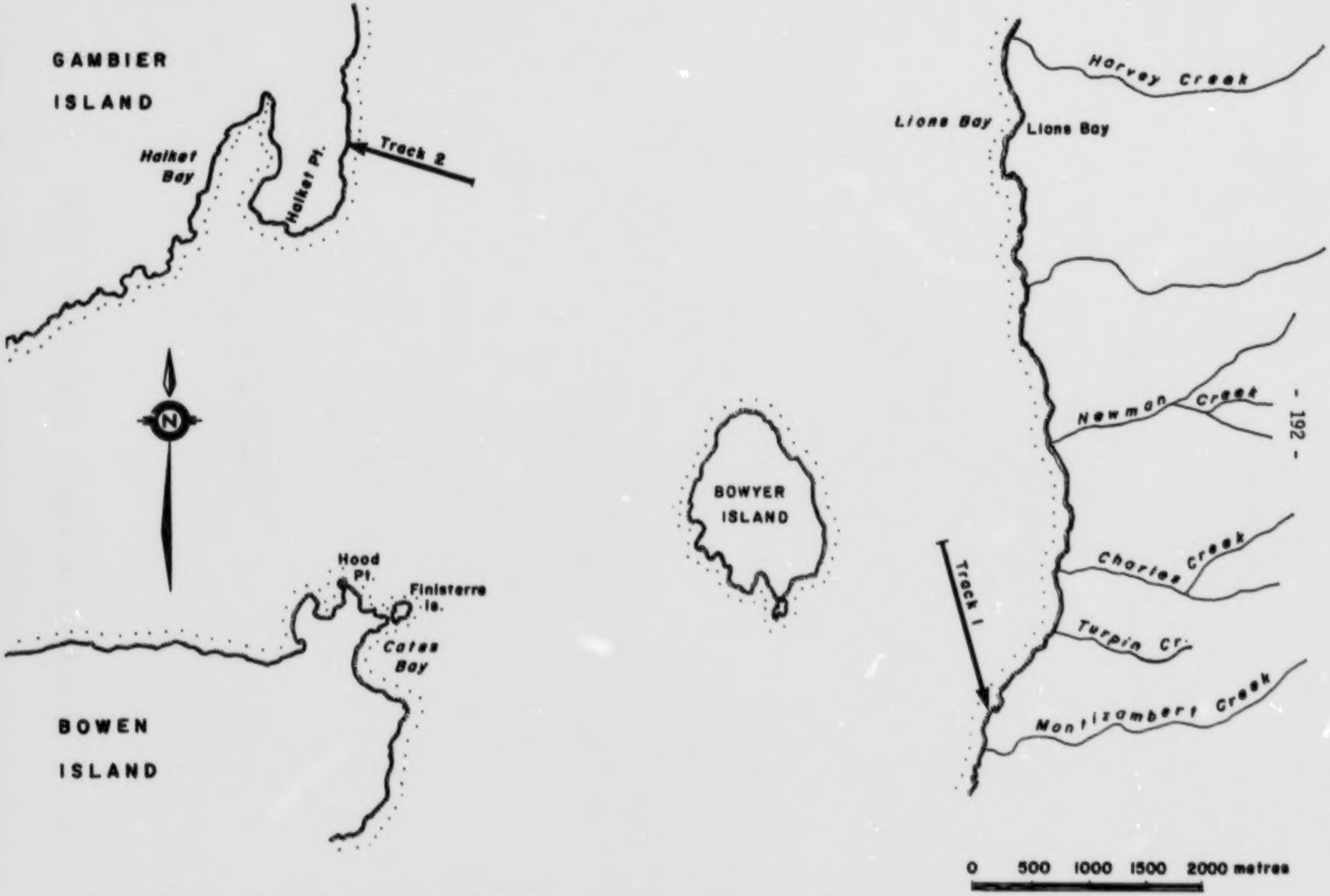
GAMBIER ISLAND
Halket Bay
Halket Pt.
Track 2
Lions Bay
Lions Bay
Harvey Creek
Newman Creek
Charles Creek
Turpin Cr.
Montizambert Creek
Track 1
BOWYER ISLAND
N
Hood Pt.
Finisterre Is.
Cates Bay
BOWEN ISLAND
0
500
1000
1500
2000 metres

FIG. 46. PISCES DIVE TRACKS, HOWE SOUND (1978).

PISCES IV DIVE RECORD

Location: Alice Arm (near Pearson Point) Date: 8 July 1982

Dive No.: 1102 (Fig. 47)

Observers: D. Goyette, R. Hinder

Position:	Start	Turn	Turn	Finish
	55°26.96'N 129°30.63'W	55°27.30'N 129°29.61'W	55°27.30'N 129°29.43'W	55°27.19'N 129°29.19'W

Depth: 107m

OBSERVATIONS:

	- turbid at surface
8.5m	- halocline - fine particles in suspension.
to 60m	- fine particles, ctenophores, chaetognaths, *Cyanea*, a few euphausids.
60m	- more ctenophores seen.
89m	- grey haze, visibility 1.2 - 1.4m
100m	- very murky
102m	- extremely murky.
107m	- reached bottom - steep slope - fresh tailing, amphipods in water column.
90m	- course 060° - sea whip in fresh tailing - ripples on surface.
61m	- some small shrimp - altered course to 090° (toward north shore).
97m	- sub frame clearly visible - water murky grey.
75m	- recontacted bottom.
90m	- again contacted bottom, visibility 2.3m.
75m	- bottom - old tailing or natural sediment - surface light brown, some burrows and animal tracks. - *Chinocetes bairdi*, *Lithodes aequispina*, *Pandalus hypsinotus* and *Pandalus borealis*.

- position - K 6.5.
- new bearing 100°.

39m - sea urchins, occasional Lithodes aequispina, Pandalus borealis, sole, small Chionocetes bairdi, pricklebacks, pink and white sea anemones, small tubes protruding from substrate.

PISCES IV DIVE RECORD

Location: Alice Arm (off Pearson Point) Date: 8 July 1982

Dive No.: 1103 (Fig. 47)

Observers: D. Goyette, D. DeMill

Position:

Start	Turn	Finish
55°26.92'N	55°26.85'N	55°26.92'N
129°29.56'W	129°29.63'W	129°29.56'W

Depth: 38m

OBSERVATIONS:

- surface water murky.

38m - bottom - visibility good.

- eelpout, *Hyas lyratus*, *Lithodes aequispina*, *Chionocetes bairdi*, pandalid shrimp.
- sediments - natural in appearance - burrows, light brown layer on surface.
- Ran west parallel to shore, found 14 cm pipe (centre of small bay west of outfall).
- Returned east to find outfall pipe at 35m, edge of turbidity cloud encountered with billowing clouds.
- Dive cancelled due to potential hazard from ropes attached to the pipe anchors.

PISCES IV DIVE RECORD

Location: Alice Arm Date: 9 July 1982

Dive No.: 1104 (Fig. 47)

Observers: D. Goyette, F. Hickey

Position:

Start	Finish
55°26.70'N	55°26.77'N
129°31.85'W	129°31.58'W

Depth: 274m

OBSERVATIONS:

	- water murky at surface.
13m	- water clear - fine suspended particles.
86m	- greyish-white appearance to water column, larger particles same as shallower.
104m	- strands in water.
155m	- large numbers of strands and particles, visibility about 3m, no further evidence of turbidity field.
250m	- murky.
272m	- occasional smelt-like fish, hyperid amphipods.
274m	- bottom - fresh tailings, surface rippled, featureless, no burrows, occasional chunks of clay. - some Pandalus borealis, one prickleback, coiled brown/black nemertean worms on surface. - visibility about 2m - left bottom.
269m	- becoming murky.
higher	- extremely murky - visibility nil.

PISCES IV DIVE RECORD

Location: Alice Arm (off Pearson Point) Date: 9 July 1982

Dive No.: 1105 (Fig. 47)

Observers: R. Hinder, L McLeod

Position:	Start	Turn	Turn	Turn	Finish
	55°27.55'N	55°27.65'N	55°27.63'N	55°27.73'N	55°27.49'N
	129°29.52'W	129°29.36'W	129°29.26'W	129°29.26'W	129°29.52'W

Depth: 99m

OBSERVATIONS:

	- murky at surface.
11m	- halocline.
40m	- larger white particles begin showing up.
70m	- odd ctenophore, particles as at 40m.
99m	- bottom - course set at 040°.
	- numerous burrows and tracks, similar to dive 1102, grey sediment with brown coating, sea whips (small).
	- ctenophores in water.
	- visibility about 1.4m.
97m	- some small logs and branches, loose *Fucus*.
	- very few shrimp, some *Chionocetes bairdi*, and eelpouts.
94m	- king crab, sea whips very common, visibility 2m.
	- larger burrows, more shrimp (mostly *Pandalopsis dispar*, some *Pandalus hypsinotus*, *Pandalus borealis*, and others).
78m	- changed course to 120°.
later	- changed course to 0°.
	- chaetognaths and euphausids in water.
79m	- 2 *Theragra chalcogramma*.
	- visibility improving.
92m	- changed course to 245°.
	- sea whips dense, several *Pandalopsis dispar*.

98m	- encountered humps about 1m high and 6m apart. - no shrimp, fewer sea whips than earlier.

PISCES IV DIVE RECORD

Location: Alice Arm (off Hans Point) Date: 10 July 1982

Dive No.: 1106 (Fig. 47)

Observers: D. Goyette, D. DeMill

Position:

	Start	Turn	Turn	Finish
	55°25.71'N	55°25.42.N	55°25.13'N	55°25.08'N
	129°40.23'W	129°40.13'W	129°40.14'W	129°40.45'W

Depth: 232m

OBSERVATIONS:

	- some surface turbidity.
8m	- halocline.
lower	- fine particles, strands (more than at head of inlet).
186m	- many suspended particles.
232m	- bottom - visibility about 5m, cobbles covered with fine silt. - small urchins. - course 170°. - light brown silt. *Chionocetes bairdi*, *Pandalus borealis*, numerous small shrimp and hermit crabs, skate, eelpouts, white *Henricia*-like starfish, *Parastichopus*, a few *Pandalopsis dispar*, *Lithodes aequispina*.
186m	- larger rocks, occasional *Pandalus borealis* and *Pandalopsis dispar*, *Lithodes aequispina*.
70m	- cobbles, boulders, small *Paragorgia* - white and pink, *Theragra chalcogramma*, *Crossaster papposus*, *Cucumaria miniata*, crinoids. - very few shrimp, clean bottom. - *Pteraster*, *Munida*, cup corals, many small *Paragorgia*.

42m	- *Strongylocentrotus pallidus*, *Crossaster* , few crustaceans, crinoids dominant, basket stars, a few sole. - outer slope of sill, fine gravel. - slightly lower visibility.
52m	- gravel - hermit crabs, basket stars, sculpins, sole, *Parastichopus*, *Colus*.
58m	- cup coral, snails, hermit crab, occasional starfish.
64m	- mud, sea whips, sea cucumbers, sea urchins. No king crab on outer side of sill thus far.
67m	- visibility lowered to 1.2 - 1.7m. Soft, light brown, smooth mud, a few burrows and animal tracks, small *Paralithodes*, very few shrimp, eelpouts, basket stars, large sculpin, *Chionocetes bairdi*.

PISCES IV DIVE RECORD

Location: Alice Arm

Date: 10 July 1982

Dive No.: 1107 (Fig. 47)

Observers: D. Goyette, D. DeMill

Position:	Start	Turn	Finish
	55°26.70'N	55°26.70'N	55°26.98'N
	129°32.49'W	129°32.04'W	129°31.86'W

Depth: 342m

OBSERVATIONS:

	(A pre-dive transmissometer profile revealed maximum trubidity at around 100 metres, elevated levels from 80-110m)
100m	- water milky.
143m	- still murky and entering another layer.
342m	- bottom - natural appearing mud, craters, burrows, light brown layer - course 090°. - *Ctenodiscus*, *Chionocetes bairdi*, numerous small sea cucumbers protruding from bottom (*Chiridota*?), occasional eelpout, a few *Pandalus borealis*, a few *Pandalopsis dispar*, 2 *Lithodes aequispina*, hermit crab.
322m	- silty appearance, entering fringe of tailing deposit.
324m	- bottom smoother, *Lithodes*.
317m	- smoother bottom, fewer burrows, few shrimp. - bottom appears striated due to ripples with light grey ridges and brown material in troughs. - clay lumps, smooth bottom - fresh tailing. - "moonscape" - barren and smooth, some animal tracks.
318m	- *Molpadia*, very few shrimp. - ridges run N-S, about 1½ cm. high.

313m	- evidence of slumping, clay lumps.
317m	- turning to shore - course 030°.
307m	- silt, clay chunks, numbers of shrimp increasing.
290m	- steep slope.
269m	- poor visibility.
237m	- still poor visibility - soft mud, craters reappearing, sea urchins, occasional sea anemone (pink/white), *Ctenodiscus*, *Crangon communis* - common, *Solaster*, small fish.
212m	- silty, visibility poor. Natural sediments, steep mud slope.
171m	- *Pandalus borealis* - numbers increasing. Very few fish seen this dive, no sole, the odd skate, several *Theragra chalcogramma*, *Chionocetes*.
	- bottom conditions similar to beginning of dive.
143m	- steep mud slope.
94m	- few flatfish.
67m	- visibility increasing, silty bottom.
	- rock with cloud sponge, brachiopods, numerous anemones (pink/white), shrimp.

PISCES IV DIVE RECORD

Location: Alice Arm (across from Hans Point) Date: 11 July 1982

Dive No.: 1108 (Fig 47)

Observers: D. DeMill, F. Hickey

Position:	Start	Turn	Finish
	55°26.68'N	55°26.27'N	55°26.48'N
	129°39.05'W	129°39.52'W	129°40.23'W

Depth: 306m

OBSERVATIONS:

78m	- large particles in water 1 - 2 cm. apart. - interstitial water clear. - ctenophores, amphipods, copepods.
100m	- long strands begin to appear.
142m	- herring, eelpout-like fish.
200m	- chaetognaths, Cyanea.
306m	- bottom - visibility 3m, soft mud bottom. - course 235°. - prickleback, Pandalopsis dispar, small pink sea cucumbers. - bottom soft mud with many tiny tubes protruding, no burrows. - white small Henricia-like starfish, a few small shrimp, small eelpouts, white sea urchins. - a few burrows now. - bottom finely dusted with light brown sediment and organic debris (bark, branches). - Lithodes aequispina, Theragra chalcogramma, Chionocetes bairdi, small Colus, small burrowing anemones. - occasional small burrows, many small tubes.
266m	- Munida, hermit crabs, tubes a little larger in diameter and protruding further from the bottom.

- getting into coarser sediment - appearance of rippled beach sand, firmer - the sub doesn't plough in as deep - no tubes.

253m - smooth river stones up to 30 cm or more in diameter.

later - tubes reappear, anemones.
- softer sediment with burrows.
- small hermit crab, small shrimp, small tubes, one *Marsipobdella sacculata* (leech) on own - others on *Lithodes*.
- small eelpout.
- sediment light grey with brown organic coating. A lot of organic debris.
- *Pandalopsis dispar*, small sculpin, *Theragra chalcogramma*.

216m - new heading 270°.
- pink anemone, *Strongylocetrotus pallidus*, *Lithodes aequispina*, several small shrimp, sponge, brittle star.
- tubes still plentiful, occasional shallow burrow.
- many small sea cucumbers.

later - have reached station U64, still heading 270°.
- shallow burrows, cucumber castings, large snail.
- visibility 3-5 metres.

216m - slope rising.
- sediment light grey beneath brown coating.
- small hermit crab, small shrimp, eelpout, scale worms.
- large rock.
- steep rock cliff - hermit crab, brachiopods, anemones, brittle stars, large *Primnoa*, starfish, anemones in tubes, small white *Paragorgia*.
- brown sediment on rock, brachiopods, tube worms, anemones in tubes, white *Cucumaria*, white *Henricia*-like starfish.
- seawhip, sponge, large sculpin, many *Strongylocentrotus pallidus*.
- smooth sediment covering part of slope, with a few burrows, small shrimp, small eelpouts, *Munida*, cup corals.

70m - rock cliff again - brachiopods, cup corals, shrimp.

PISCES IV DIVE RECORD

Location: Alice Arm

Date: 11 July 1982

Dive No.: 1109 (Fig. 47)

Observers: R. Hinder, L. McLeod

Position:	Start	Turn	Finish
	55°27.10'N	55°26.98'N	55°27.27'N
	129°36.07'W	129°35.48'W	129°35.40'W

Depth: 362m

OBSERVATIONS:

	- long mucous strands, eelpout-like fish.
362m	- visibility 2/3 metre. - sediment gray with light brown dusting. - large and small burrows, some animal trails, a few shrimp.
355m	- *Lithodes aequispina*.
340m	- visibility 1m. - 2 shrimp every second, at one knot speed. Mostly *Pandalopsis dispar*, some *Pandalus borealis*, and others. - several eelpouts and pricklebacks.
299m	- rock face, sea cucumbers.
287m	- equal amounts *Pandalopsis dispar* and *Pandalus borealis*, (about 6 in view at one time).
225m	- visibility 3-4m. - more *Pandalus borealis* than *Pandalopsis dispar* and shrimp more abundant overall (10-15 in view at one time). - some grey patches where the brown coating has been cleared from the substrate.
210m	- some large burrows - up to 15 cm. across.
175m	- sea anemone.
169m	- smaller burrows. Even numbers of *Pandalopsis dispar* and *Pandalus borealis* plus smaller shrimp.
surfaced	- many long mucous-like strands in water column.

PISCES IV DIVE RECORD

Location: Hastings Arm (Grenby Bay) Date: 12 July 1982

Dive No.: 1110 (Fig. 47)

Observers: D. Goyette, D. DeMill

Position:	Start	Finish
	55°24.18'N	55°24.48'N
	129°49.30'W	129°48.90'W

Depth: 90m

OBSERVATIONS:

	- turbid at surface.
90m	- at bottom - fairly smooth, occasional burrows. - surface sediment brownish. - visibility 1m. - very many shrimp - mainly Pandalus borealis, some Pandalopsis dispar.
later	- visibility improved to 1½m.

PISCES IV DIVE RECORD

Location: Alice Arm

Date: 13 July 1982

Dive No.: 1111 (Fig. 47)

Observers: D. Goyette, R. Hinder

Position:

Start	Turn	Turn	Turn	Finish
55°26.70'N	55°26.76'N	55°26.80'N	55°26.87'N	55°26.84'N
129°31.13'W	129°31.04'W	129°31.04'W	129°30.97'W	129°30.89'W

Depth: 240m

OBSERVATIONS:

(Consists solely of transmissometry in mid-water).

229m	- getting fairly turbid - starting horizontal run-course 045°. - (bottom 240m).
general	- a few Cyanea (jellyfish) have been seen.
218m	- changed course to 000°.
145m	- fairly turbid.
118m	- still turbid. - changed course to 030°.
119m	- changed course to 120°. - very turbid. As course continued turbidity increase at first, then cleared somewhat.

PISCES IV DIVE RECORD

Location: Hastings Arm (off Carr Point) Date: 13 July 1982

Dive No.: 1112 (Fig. 47)

Observers: D. Goyette, D. DeMill

Position:

	Start	Turn	Finish
	55°28.82'N	55°29.00'N	55°29.12'N
	129°45.32'W	129°45.46'W	129°44.92'W

Depth: 296M

OBSERVATIONS:

24m
- many particles, interstitial water clear.
- little zooplankton.

later
- less large white particles near the bottom.
- occasional smelt-like fish. Fish not common.

296m
- bottom - silty, surface light brown, mounds greyish.
- many small burrows and craters.
- *Ctenodiscus crispatus* frequent, occasional *Pandalus borealis*, one *Theragra chalcogramma*, triton (snail), *Pandalopsis dispar*, animal tracks.
- visibility 1-2m, fine suspended particles.
- shrimp spaced about 1m - apart.
- octopus.
- sediment around burrows grey.
- shrimp distribution patchy - some areas none.
- very few eelpouts, no flatfish, one *Pandalopsis dispar*.

283m
- large craters common, no rippling.
- *Ctenodiscus crispatus* frequent - some buried.
- occasional burrowing anemones, *Pandalopsis dispar*.
- shrimp do not seem as abundant as in 1976 dives.
- prickleback.
- no hermit crabs.

270m	- steep rock face. - brachiopod shells at base. - rock face covered in brachiopods. - anemones, white *Henricia*-like starfish, *Balanus nubilis*, one *Lithodes aequispina*.
241m	- occasional pandalid shrimp - fair distance between individuals.
216m	- gradual incline. - occasional eelpout, one *Anoplopoma fimbria* (sablefish). - a few small shrimp, poacher, snailfish.
200m	- shrimp a little more abundant - *Pandalopsis dispar*, pandalids, a few spirontocarids. - *Ctenodiscus*, *Chionocetes bairdi*, another *Anoplopoma fimbria*.
183m	- steep muddy slope - uneven surface, some burrows. - many shrimp.
136m	- base of cliff, nearly vertical. - light dusting of silt on ledges. - brachiopods, cloud sponges, small white *Henricia*-like starfish.
138m	- some *Parastichopus*, a triton, occasional *Munida* and *Stronglocentrotus pallidus*, some sea cucumbers.
100m	- very few shrimp. - surfaced.

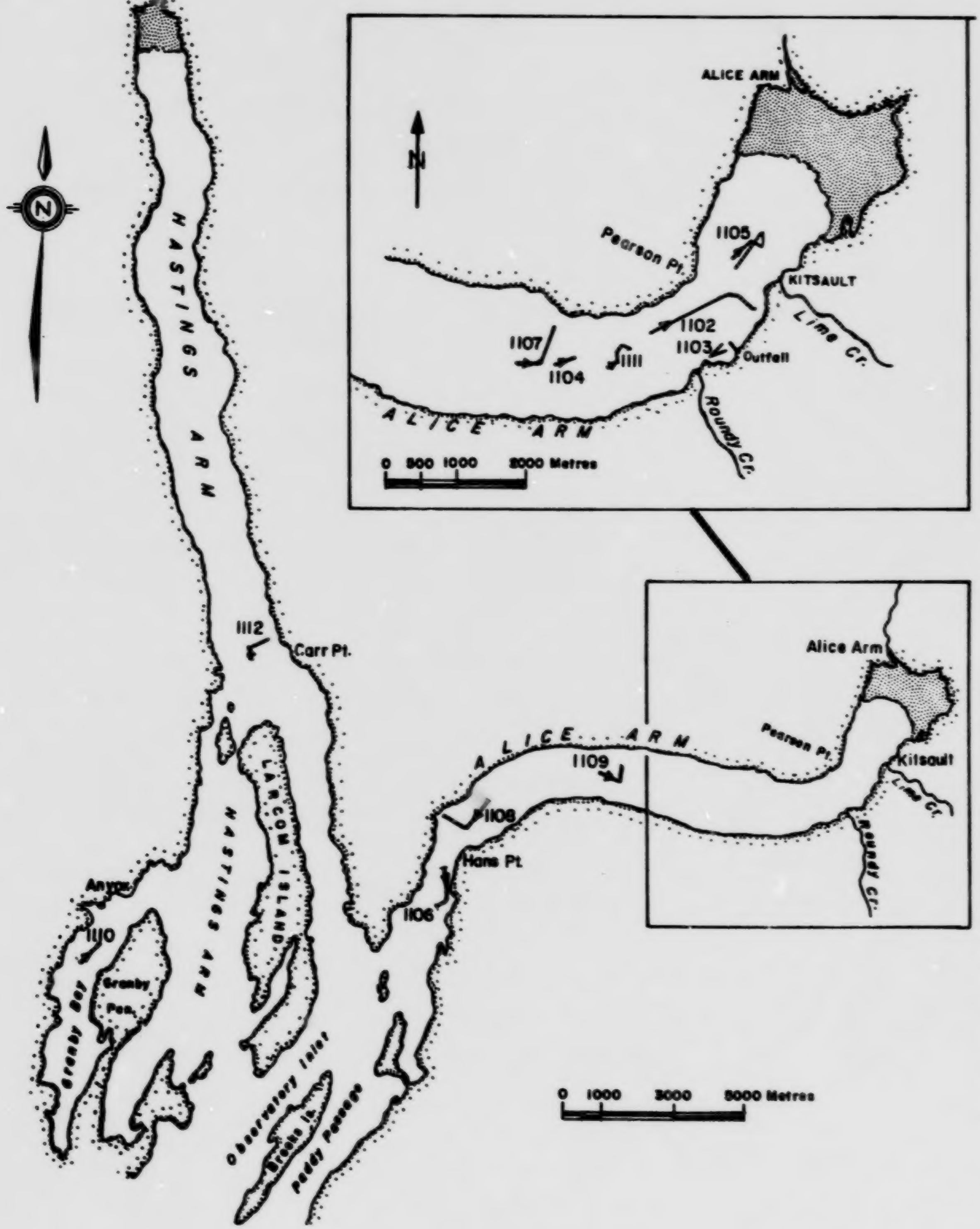
ALICE ARM
N
Pearson Pt.
1105
KITSAULT
Lime Cr.
1102
1107
1103
Outfall
1104
1111
Roundy Cr.
ALICE ARM
0 500 1000 2000 Metres
Alice Arm
Pearson Pt.
Kitsault
Lime Cr.
Roundy Cr.
N
HASTINGS ARM
1112
Carr Pt.
LARCOM ISLAND
HASTINGS ARM
ALICE ARM
1109
1108
Hans Pt.
1106
Anyox
1110
Granby Pen.
Granby Bay
Observatory Inlet
Brooks Is.
Paddy Passage
0 1000 3000 5000 Metres

FIG. 47 PISCES IV SUBMARINE DIVE SITES - ALICE ARM AND HASTINGS ARM - July, 1982

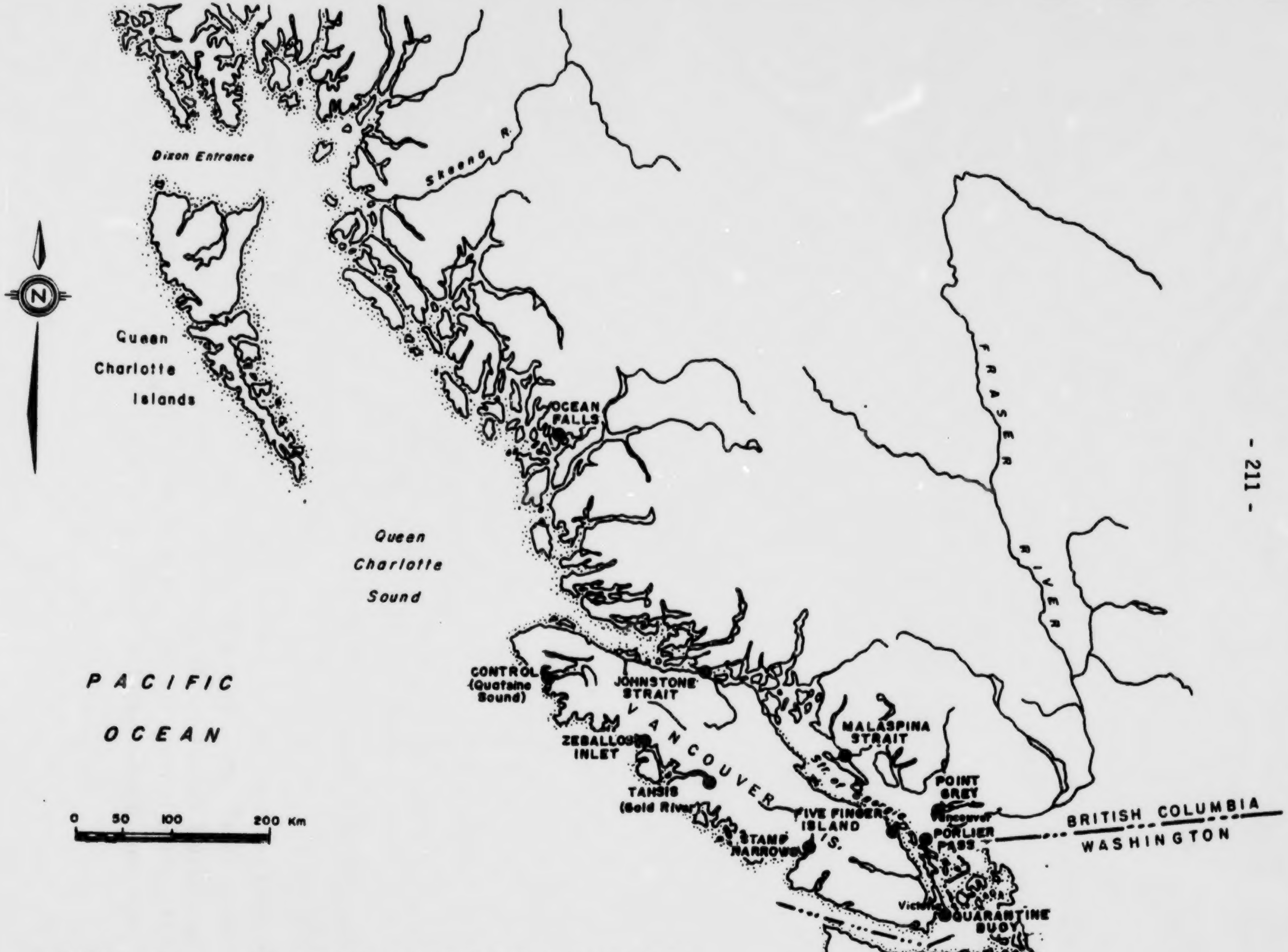
Dixon Entrance
Skeena R.
N
Queen Charlotte Islands
OCEAN FALLS
Queen Charlotte Sound
FRASER RIVER
PACIFIC OCEAN
CONTROL (Quatsino Sound)
JOHNSTONE STRAIT
VANCOUVER I/S.
ZEBALLOS INLET
TAHSIS (Gold River)
MALASPINA STRAIT
Str. of Georgia
POINT GREY
Vancouver
FIVE FINGER ISLAND
PORLIER PASS
STAMP NARROWS
Victoria
QUARANTINE BUOY
BRITISH COLUMBIA
WASHINGTON
0
50
100
200 Km

FIGURE 48 LOCATION OF OCEAN DUMPSITES

PISCES IV DIVE RECORD

Location: Point Grey Date: 23 January 1976

Dive No.: (Tracks 1, 2, 3, 3A, 4, and 5) (Fig. 49)

Observers: N. Holman, R. Hoos, G. Packman

Position:

	Start	Finish
Track 1	49°16.70'N	49°16.09'N
	123°22.04'W	123°21.97'W
Track 2	49°15.76'N	49°15.93'N
	123°21.04'W	123°20.12'W
Track 3	49°16.66'N	49°17.17'N
	123°19.83'W	123°20.72'W

Date: 24 January 1976

	Start	Finish
Track 3A	49°16.97'N	49°16.72'N
	123°19.76'W	123°20.73'W
Track 4	49°17.55'N	49°18.13'N
	123°20.19'W	123°20.19'W
Track 5	49°15.42'N	49°15.42'N
	123°22.43'W	123°23.58'W

Depth: ca 250m

Submersible Observations and Photography Point Grey 1976

(Tracks 1, 2, 3, 3a, 4, 5)

During the course of the "PISCES" dives, approximately eight hours of videotape, two hours of 16mm film, and 350 still photographs were generated, as well as many visual impressions not recorded by any of the aforementioned media. This information is presently being examined and edited, to be retained as a permanent photographic record of conditions as they existed in 1976.

In many ways the "PISCES" dives confirmed the insights gained from examination of the material collected by the beam trawl and benthic grab surveys. Relatively little dumped material was found within the dump site boundary, and virtually none occurred in the southern and western hemispheres. Epibenthic life and demersal fish were scarce in these areas. The benthos of all transects was deduced to be primarily infaunal owing to the abundant burrows and castings occurring on the mud surface.

Most of the debris noted had been deposited in the northern and eastern sections of the study area, with considerably more occurring outside, than inside, the limits of the designated dump site. Within the boundary, the most common materials found were lumps of hardpan clay and some wood debris, including a few deadheads. Outside the dump site, particularly along tracks 3, 3a, and 4, there were large quantities of construction rubble (including concrete pillars, reinforcing rods and cables), dredged material, and wood wastes. In some areas, regular mounds up to 2 metres high were found. These larger deposits were presumably the result of dumping by bottom-dump barges, the only likely mechanism whereby mounds of this scale could be generated. As would be expected, the deposits were randomly distributed, although more were present along transects 3, 3a, and 4.

With regard to the biological communities inhabiting the areas of concentrated debris, exposed objects such as deadheads, concrete blocks, scrap iron, etc., were attractive to many of the epibenthic macrofauna, including anemones, shrimp, and prawns, as well as to various species of fish. Apparently, the nooks and crannies provided niches with a measure of protection from predators, as well as firm substrates for the attachment of certain sessile organisms. This is a typical phenomenon experienced in the construction of artificial reefs in shallow waters and around shipwrecks. Many of the deadheads encountered were in an advanced state of decay, primarily due to heavy shipworm (Bankia sp.) infestations. Several were also covered in unidentified fungal and/or bacterial growths. In two instances, hundreds of large snails (Neptunea sp.) were found on logs covered with this growth. It is not yet clear whether the snails were feeding on the fungal and/or bacterial matter, or whether they were simply exhibiting a swarming behaviour for mating purposes.

The numerous holes and castings indicative of infaunal populations of polychaetes, holothurians, echinoids, and crustacea prevailed throughout the study area, inlcuding those sites where concentrated dumping has occurred. In fact, they were even found over all the large mounds described earlier, suggesting that infaunal recolonization of smothered areas was taking place.

The relatively shallower depths and the presence of noticeable bottom currents (as opposed to the negligible water movements typical of the dump site) along tracks 3, 3a, and 4, have apparently provided optimum conditions for ophiurioids. A dense population was found covering the bottom, including the areas of deposition, along the entire length of these transects.

In summary, "the PISCES dives" confirmed that the majority of the material dumped off Point Grey was, in fact, not found at the designated site, but rather to the northeast, toward the City of Vancouver. Many of the areas surveyed with "PISCES" were impossible to sample with trawling gear due to the variety of debris on the bottom. However, this debris did not appear to be adversely affecting the epibenthic macrofauna and served to attract to these areas many of the major life forms found. Nevertheless, these conclusions should not be considered a sanction for ocean disposal in sites other than those officially designated. In many locations, including the Point Grey area, a valuable trawl fishery exists in the more productive near-shore regions. Should such areas be littered with debris, fishermen would find it impossible to trawl their nets over the bottom.

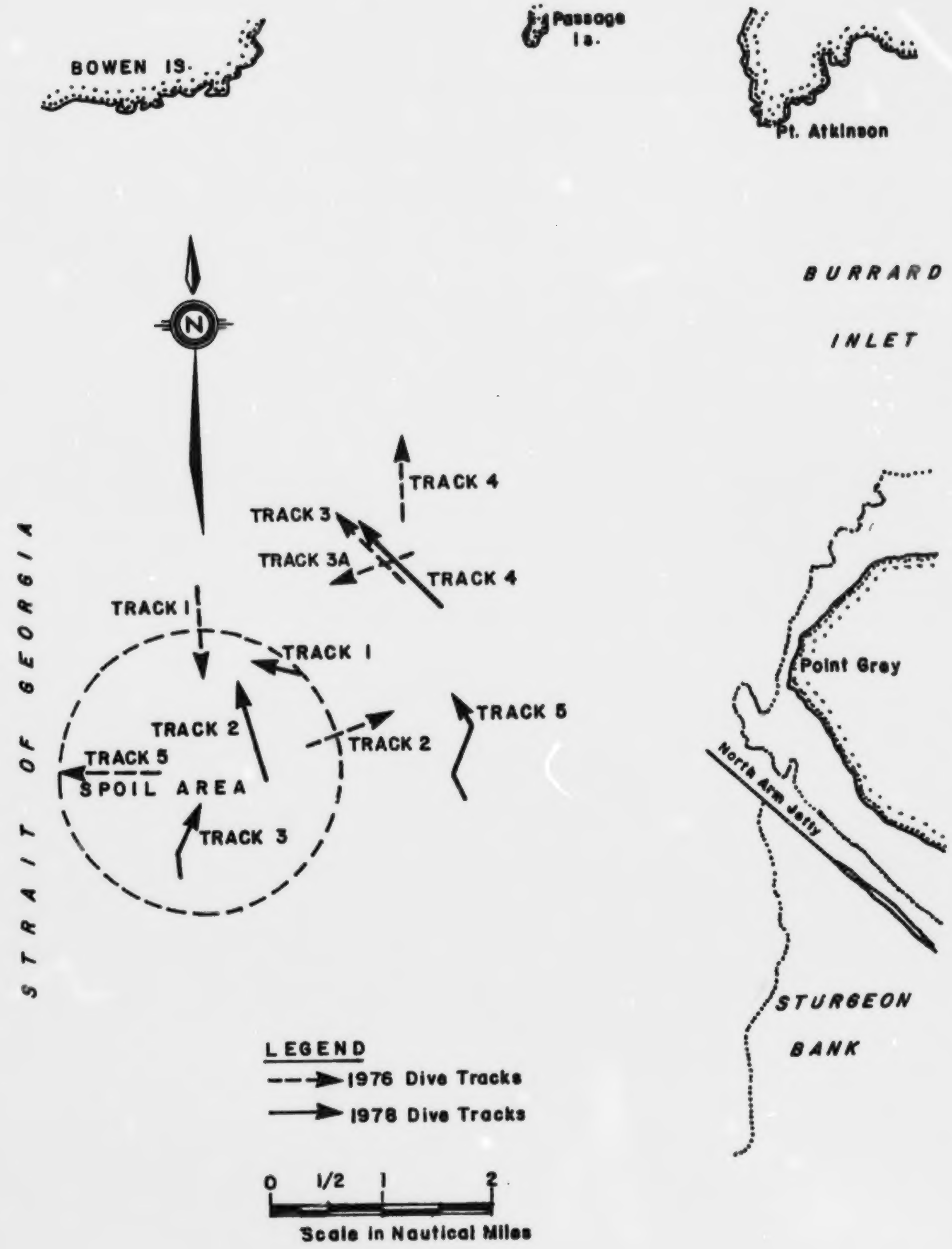
BOWEN IS.
Passage Is.
Pt. Atkinson
BURRARD INLET
N
STRAIT OF GEORGIA
TRACK 4
TRACK 3
TRACK 3A
TRACK 4
TRACK 1
TRACK 1
TRACK 2
TRACK 2
TRACK 5
TRACK 5
SPOIL AREA
TRACK 3
Point Grey
North Arm Jetty
STURGEON BANK
LEGEND
1976 Dive Tracks
1978 Dive Tracks
0 1/2 1 2
Scale in Nautical Miles

FIG. 49 PISCES DIVE TRACKS AT POINT GREY DUMPSITE (1976 and 1978)

PISCES IV DIVE RECORD

Location: Port Mellon (Thornbrough Channel) Date: 26 January 1976

Dive No.: 380 (Tracks 1 and 2) (Fig. 50)

Observers: N. Holman (Track 1), J. Landucci (Track 2)

Position:

	Start	Finish
Track 1	49°31.86'N 123°26.32'W	49°31.52'N 123°27.20'W
Track 2	49°31.24'N 123°28.10'W	49°30.95'N 123°28.13'W

Depth: 130m

Note: No dive report available.

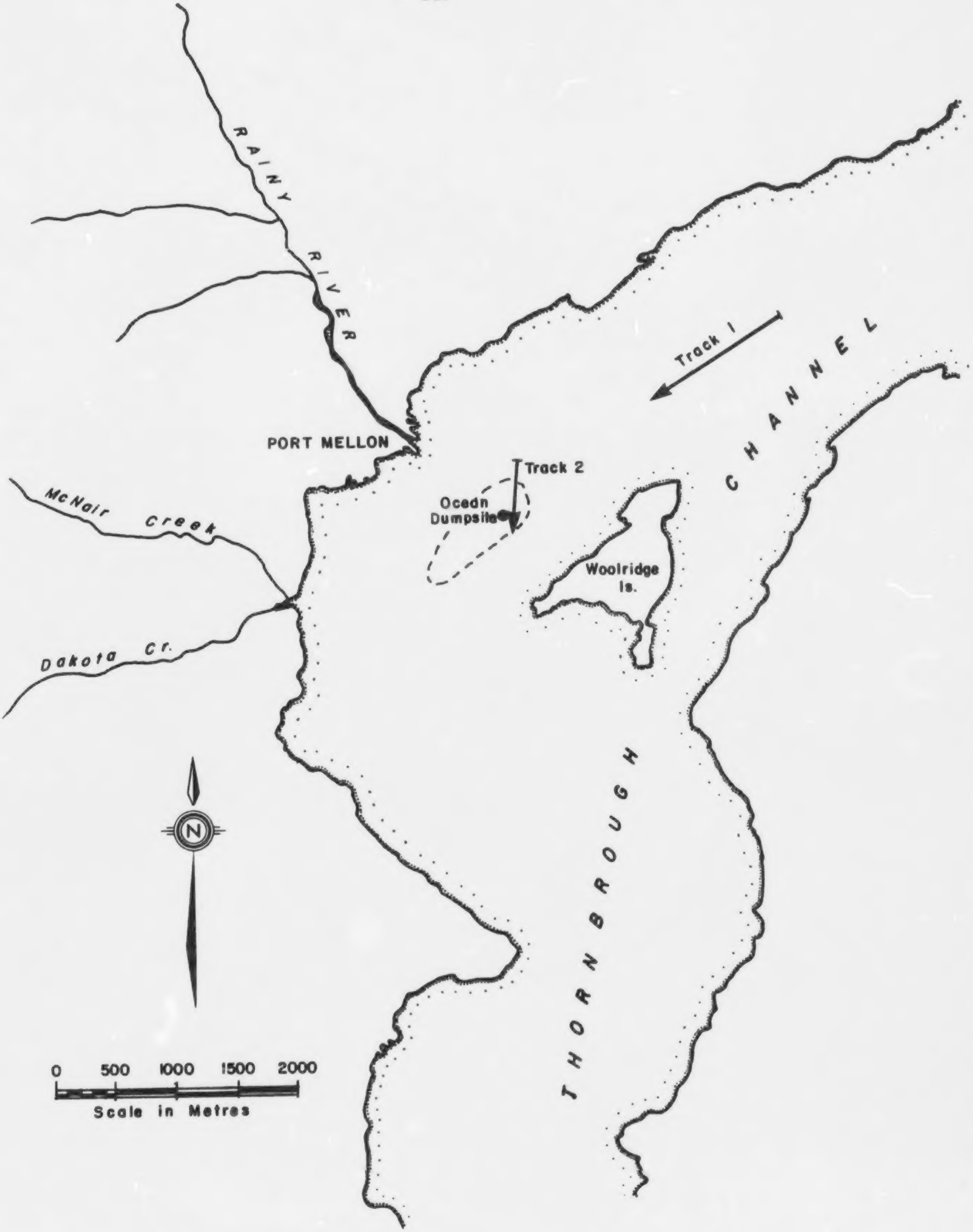
RAINY RIVER
PORT MELLON
Track 1
CHANNEL
Track 2
Ocean Dumpsite
Woolridge Is.
McNair Creek
Dakota Cr.
N
THORNBROUGH
0
500
1000
1500
2000
Scale in Metres

FIG. 50 PISCES DIVE TRACKS, PORT MELLON DUMPSITE (1976).

PISCES IV DIVE RECORD

Location: Port Mellon Date: 26 January 1976

Dive No.: 381 (Fig. 51)

Observer: R. Hoos

Position:

	Start	Finish
	49°30.71'N	49°30.98'N
	123°28.44'W	123°28.90'W

Depth: 130m

Note: No dive report available.

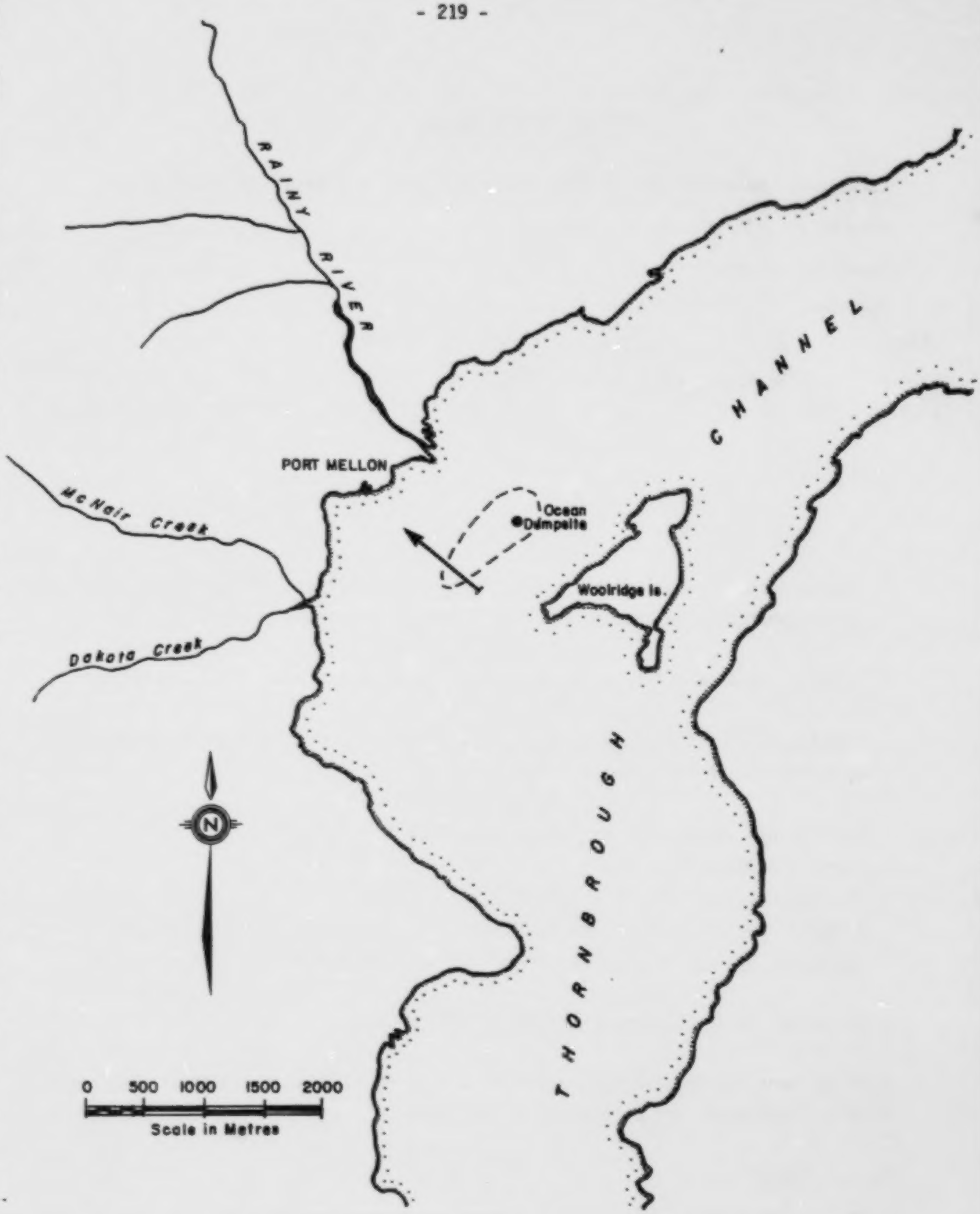
RAINY RIVER
McNair Creek
Dakota Creek
PORT MELLON
Ocean Dumpsite
Woolridge Is.
CHANNEL
THORNBROUGH
N
0
500
1000
1500
2000
Scale in Metres

FIG. 51 PISCES DIVE TRACK, PORT MELLON DUMPSITE (1976).

PISCES IV DIVE RECORD

Location: Malaspina Strait (off Beaver Island) Date: 30 August 1976

Dive No.: 470 (Track 1) (Fig. 52)

Observer: R. Hoos

Position:

Start	Turn	Turn	Turn	Turn	Turn	Finish
49°36.60'N	49°36.90'N	49°36.93'N	49°36.91'N	49°37.25'N	49°37.28'N	49°37.42'N
124°05.50'W	124°05.60'W	124°04.86'W	124°04.70'W	124°04.40'W	124°04.46'W	124°04.56'W

Depth: 215m

Water Column

- The surface water was characterized by a pea soup green colour, heavily laden with what appeared to be organic detritus, probably primarily planktonic algae.

- Natural light penetration (visible light) extended to a depth of 20 metres.

- Organic detritus continued to the bottom (215m) with the heaviest concentration occurring in the top 50m.

- Considerable zooplankton activity encountered
  Juvenile euphausids at 65m
  Adult euphausids from 75m - 100m
  Gammarid amphipods, including *Cyphocaris* several species of small medusae (*Aglantha*, *Aegina*, *Aeguorea*), ctenophores (*Pleurobrachia*, *Beroë*) at 100-125m.

- Occasional squid observed from 160m to bottom 215m.

- At and near bottom observed considerable numbers of decapod crustacea (*Pasiphaea*), hyperiid amphipods, and polychaetes (*Tomopteris*).

Benthic Fauna

- Once on the bottom (215m) PISCES covered a transect heading generally northeast and terminating at a depth of 20 metres.

- During the dive several rock "steps" were encountered, separated by relatively flat mud plains.

The following is a general summary of observations. The first 20 minutes of the track was on a flat silt/sand bottom at a depth of 215-190 metres. Some exposed Chiridota sp. were seen as well as several cod, hake, eelpouts, pink shrimp (P. borealis), numerous Munida and large burrows. We then proceeded to climb a series of steps terminating the dive at 20 metres.

The mud "plains" in between the ledges were all similar except that prawns became more common (approx. 1-2/m^2) at between 150m and 75m. Shallower than 50m, prawns and shrimp became scarce. Munida remained common throughout but were generally large above 100m. They were particularly abundant on the rock ledges as were glass sponges (Aphrocallistes and unidentified cylindrical species). A variety of species of rockfish concentrated around the ledges. These included harlequin (Sebastes variegatus), stripetail (S. saxicola), redstripe (S. proriger), tiger (S. nigrocinetus), quillback (S. maliger), and Pacific Ocean perch (S. alutus).

Some soil, flounders, grey cod and hake were found on all flat muddy substrates with higher numbers encountered between 125 and 50 metres. Ratfish and some dogfish were observed regularly at all depths.

Between 35m and 20m life forms typical to the shallow littoral zone were observed (Parastichopus, Leioptilus, Mytilus, Pisaster, Henricia, Cancer, Strongylocentrotus, Chlamys, etc.).

In terms of debris, through the course of the dive, only 4 deadheads, one tire, a few beer/pop bottles, a tangle of fishing line and an old newspaper were encountered.

In comparing this area to similar sites at Point Grey and Port Mellon, I feel that the Malaspina Strait site harbours a considerably greater variety as well as numbers of pelagic fish and epibenthic macrofauna. The dive observations indicated that the largest standing crop of epifaunal organisms occurred within the 150-50 metre zone and that they concentrated around rock ledges and hard objects.

Note: no page 222; 223 next

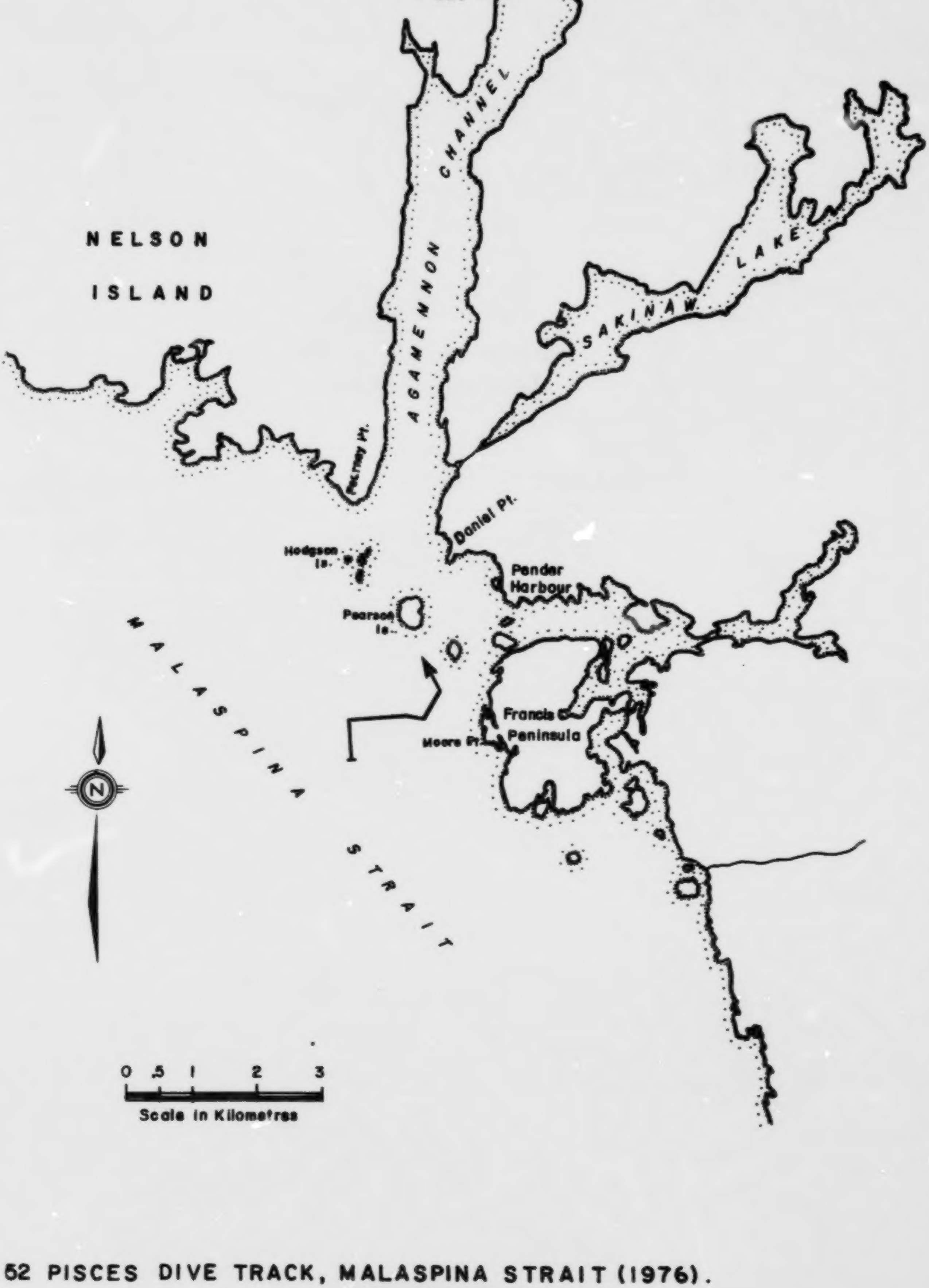
NELSON ISLAND
AGAMENNON CHANNEL
SAKINAW LAKE
Daniel Pt.
Hodgson Is.
Pender Harbour
Pearson Is.
Francis Peninsula
Moore Pt.
MALASPINA STRAIT
N
0 .5 1 2 3
Scale in Kilometres

FIG. 52 PISCES DIVE TRACK, MALASPINA STRAIT (1976).
(PROPOSED DUMPSITE)

PISCES IV DIVE RECORD

Location: North of Powell River (between Harwood Is. and the mainland)

Date: 31 August 1976

Dive No.: 471 (Track 2) (Fig. 53)

Observer: N. Holman

Position:

	Start	Finish
	49°52.30'N	49°52.92'N
	124°35.60'W	124°35.65'W

Depth: 145m

Note: No dive report available.

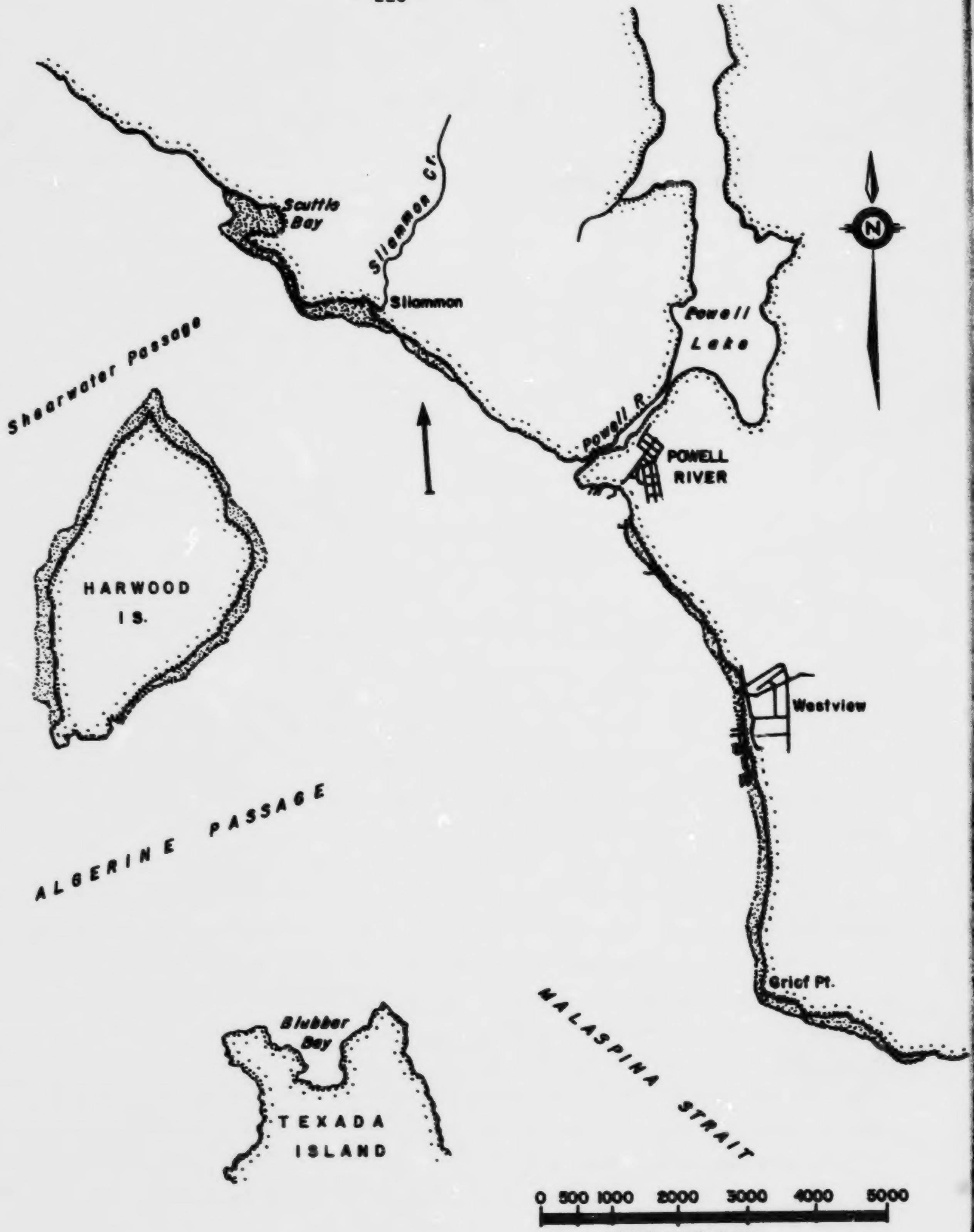
Scuttle Bay
Sliammon Cr.
Sliammon
Powell Lake
Powell R.
POWELL RIVER
Shearwater Passage
HARWOOD IS.
Westview
ALGERINE PASSAGE
Grief Pt.
MALASPINA STRAIT
Blubber Bay
TEXADA ISLAND
N
0 500 1000 2000 3000 4000 5000
Scale in Metres

FIG. 53 PISCES DIVE TRACK, NORTH OF POWELL RIVER (1976).

PISCES IV DIVE RECORD

Location: Strait of Georgia (off Nanaimo Harbour) Date: 1 September 1976

Dive No.: 475 (Track 6) (Fig. 54)

Observers:

Position:

	Start	Finish
	49°12.35'N	49°10.31'N
	123°53.40'W	123°53.58'W

Depth: 120m

Observations of the water column during descent showed considerable suspended detritus.

Touched bottom at 1600 hours at 120m. Visibility 1.5m. The bottom was noted to be a typical mud/silt bottom and first observations were of small hake, red snapper and later, numerous red snapper. Shrimp were in evidence. At approximately one-third of the way along the track, a long (5m) log was noted and shortly after several iron bars or rods were seen protruding from the bottom. Small sole and hermit crabs were seen. Occasional rocks and boulders were noted with squat lobsters and burrowing anemones in the vicinity. The bottom gently sloping upwards became rockier with an overlying layer of silt. Small white sponges (Aphrocallistes) and starfish (Mediaster) were evident in this area. An old discarded tire was found to contain an octopus (60 cm. extended). Brown and white banded rockfish (Scorpaenidae) were observed and later a random distribution of iron rods and rusting debris; remains of a fish net in the area might indicate that the debris caused the loss of this net. Another small octopus was sighted; small white seapens (1.2m), ratfish, yellow starfish (Pteraster), and a very large new log (stripped of bark). More cable or twisted steel rod was noted. The bottom terrain became more undulating in a depth of approximately 80m and two large mounds were seen. The area appeared to be covered in many more boulders. Brittle stars were prevalent and one large white seapen was seen. At 75m there appeared to be many crabs (Cancer magister). The terrain changed to mounds of small stones or crushed rock covered with a thin layer of silt, numerous squat lobsters were noted. Several eelpouts were also in evidence in this area and an abundance of crabs (Cancer magister).

The dive terminated in 70m at 1730 hours. As a general comment, it would appear that the several mounds noted in this area appeared to show evidence of past-dumped material or at least dumped material was in evidence in the general area of those mounds. However, it was also true that the most abundant marine life was observed in the latter part of the surveyed track.

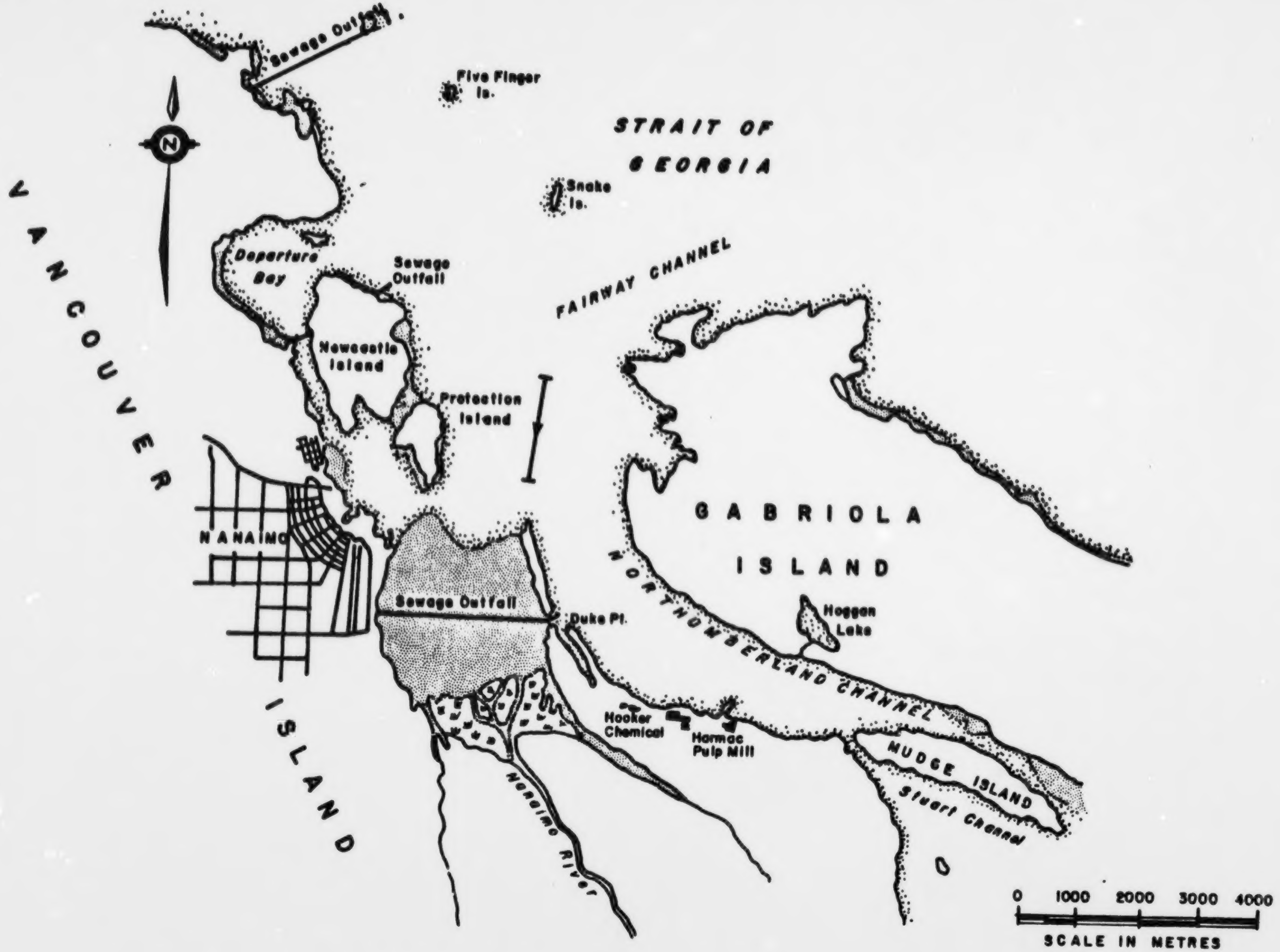
Sewage Outfall
Five Finger Is.
STRAIT OF GEORGIA
Snake Is.
N
VANCOUVER
Departure Bay
Sewage Outfall
FAIRWAY CHANNEL
Newcastle Island
Protection Island
NANAIMO
GABRIOLA ISLAND
Sewage Outfall
Duke Pt.
NORTHUMBERLAND CHANNEL
Hoggan Lake
Hooker Chemical
Harmac Pulp Mill
MUDGE ISLAND
Stuart Channel
Nanaimo River
ISLAND
0 1000 2000 3000 4000
SCALE IN METRES

FIG. 54 PISCES DIVE TRACK, STRAIT OF GEORGIA (OFF NANAIMO HARBOUR) 1976.

PISCES IV DIVE RECORD

Location: Porlier Pass

Date: 2 September 1976

Dive No.: 477 (Track 8) (Fig. 55)

Observers: V. Bradshaw, G. Packman

Position:	Start	Turn	Turn	Turn	Finish
	49°01.64'N	49°01.93'N	49^{9}01.61'N	49°01.83'N	49°01.61'N
	123°33.51'W	123°33.31'W	123°33.05'W	123°32.90'W	123°33.05'W

Depth: 178m

Current - approximately 1.85 km/hr from 110°T

Bottom Characteristics

The bottom was a typical mud bottom characterized by an exceptionally large number of holes and burrows.

Benthic Fauna

The major visible lifeforms were brittle stars (*Ophuira sarsi*) and eelpouts (Zoarcidae). The brittle stars were as abundant in this location as the ones observed off Point Grey.

Other epifauna observed included sponges, nemerteans, burrowing anemones (*Pachycerianthus* sp.), starfish (possibly *Dipsacaster* sp. or *Pseudochaster* sp.), hermit crabs (*Paguridae*), pink shrimp (*Pandalus borealis*), squat lobsters (*Munida quadraspina*), crangon and juvenile ratfish (*Hydrolagos colliei*).

Speculation on the infauna was that it contained representatives of Leptosynapta and Maldanidae. Speculation was made after a hole was dug up with the small manipulator arm of PISCES. A sample of mud was placed in the sample box. This was later found to contain species of *Rhabdamina* sp., (a "stock like" member of the Order Foraminifera), and the polychaeta families Nephtydae and Maldanidae.

Summary

The lack of visibility and strong currents had the effect of curtailing the distance which could be covered with PISCES. However what was seen indicated active and prolific populations of both epi- and infaunal organisms.

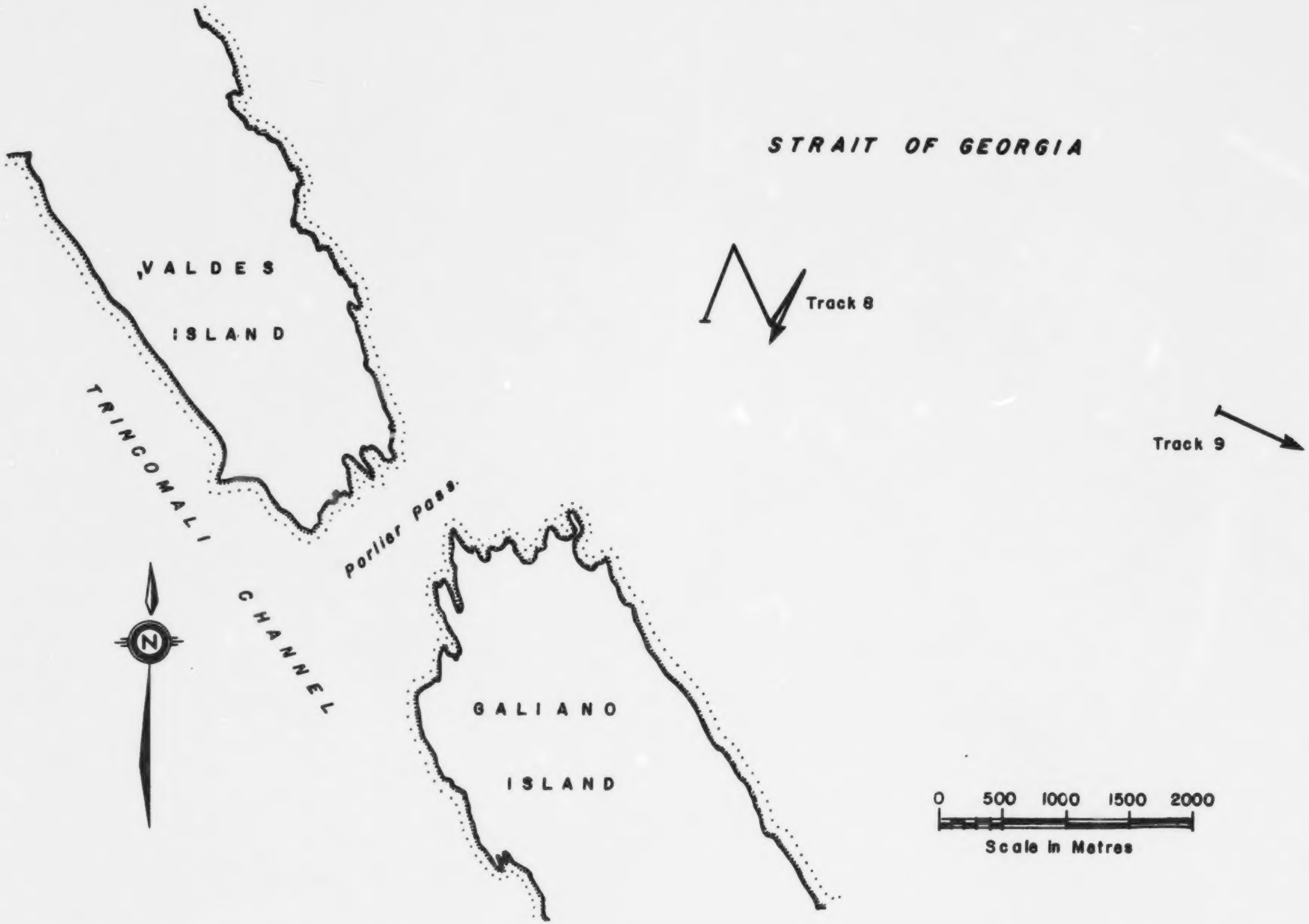
STRAIT OF GEORGIA
Track 8
Track 9
VALDES ISLAND
TRINCOMALI CHANNEL
Porlier Pass
GALIANO ISLAND
N
0 500 1000 1500 2000
Scale in Metres

FIG. 55 PISCES DIVE TRACKS, OCEAN DUMPSITE OFF PORLIER PASS (1976).

PISCES IV DIVE RECORD

Location: Porlier Pass

Date: 2 September 1976

Dive No.: 478A (Track 9) (Fig. 56)

Observers: N. Holman, G. Packman

Position:

Start	Finish
$49^{o}01.30$'N	$49^{o}01.14$'N
$123^{o}30.29$'W	$123^{o}29.80$'W

Depth: 250m

Location: Porlier Pass

Date: 3 September 1976

Dive No.: 478B (Track 10) (Fig. 57)

Observers:

Position:

Start	Finish
$48^{o}59.48$'N	$48^{o}59.37$'N
$123^{o}28.86$'W	$123^{o}29.02$'W

Depth: 250m

Visibility - approximately 1.2m.

Current - approximately 1.85 km/hr from 0^{o}T

Bottom Characteristics

Initially the bottom was exactly the same as the previous dive off Porlier Pass. That is, it was a mud bottom characterized by extensive epi-and infaunal populations. The bottom began sloping however and the mud bottom gave way to a bottom of rock under a light covering of mud. About halfway through the dive a rock cliff was found which was densely populated with epifauna. The cliff ran 030^{o} - 040^{o}T and was approximately 9-14m in height.

Benthic Fauna

Mud Bottom

The mud bottom was characterized by holes indicating an extensive infauna and an epifauna including crangon, pink shrimp (*Pandalus borealis*), nemerteans, an unidentified gastropod, an unidentified asteroid, and a sole (Pleuronectidae).

Transition Zone (Mud to Rock)

This zone was characterized by an increased epifauna including bryozoans, increased numbers of gastropods, brittle stars (Ophinra sp.), squat lobsters (Munida quadraspina), crangon, cup corals, unidentified asteroid and sponges, burrowing anemones (Pachycerianthus sp.) and solitary tunicates (Ascidiacea).

Rock Cliff

The rock cliff was densely populated thus making it almost impossible to detail every life form present. The films obtained should be consulted in order to properly list the species present. Some that were listed included, a variety of unidentified sea anemones, Terebratula sp., white bryozoans, solitary ascidians, a white asteroid (possibly Dipsacaster sp. or Pseudarchaster sp.), a yellow starfish (Pteraster tesselatus arcuatus) as well as numerous ratfish (Hydrolagos colliei) and one skate.

Summary

This area appeared to be quite productive, probably due to the variety in substrate and the relatively strong current which is prevalent. Again current and lack of visibility hampered operations.

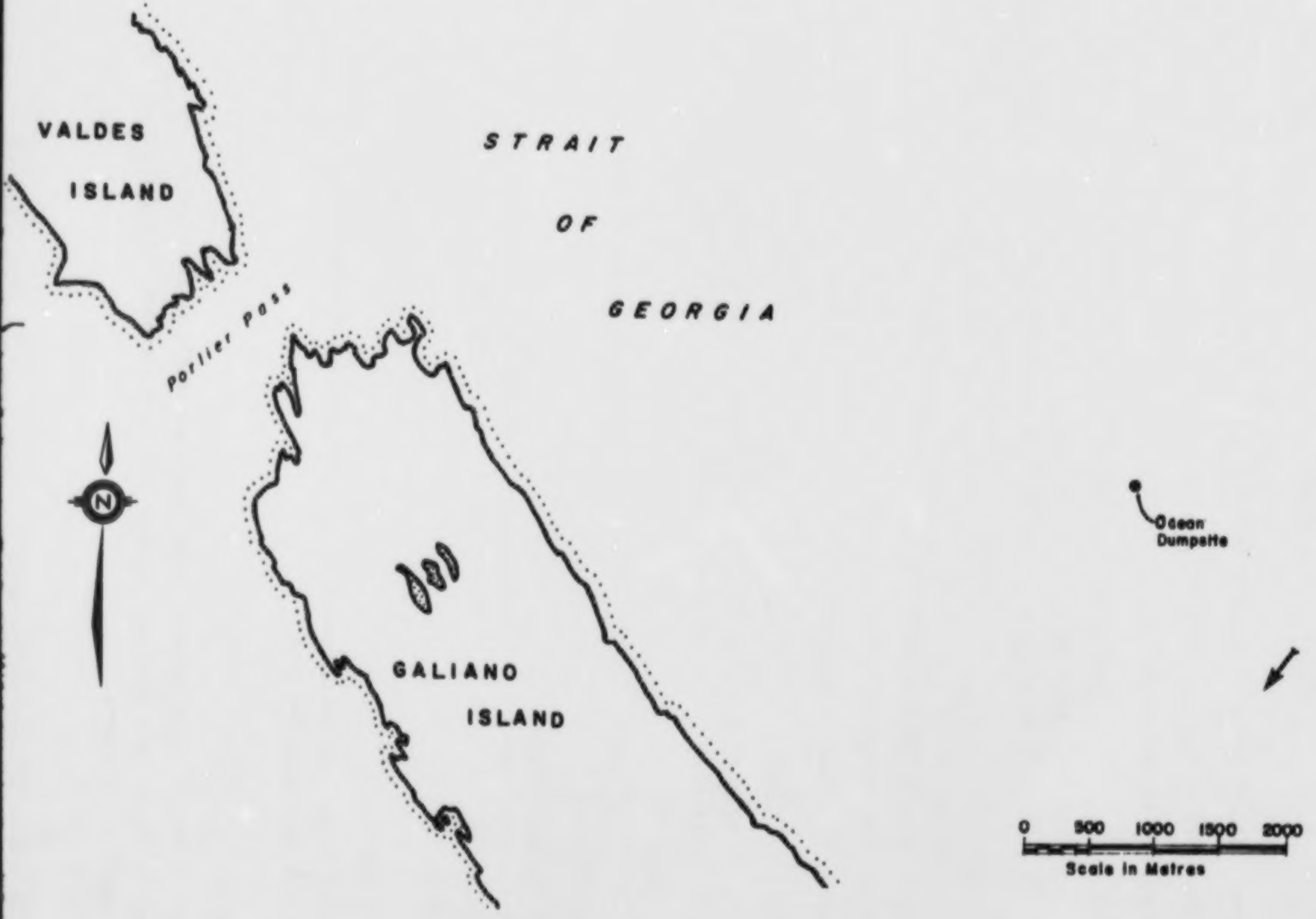
VALDES
ISLAND
STRAIT
OF
GEORGIA
Porlier Pass
N
GALIANO
ISLAND
Ocean
Dumpsite
0
500
1000
1500
2000
Scale in Metres

FIG. 56 PISCES DIVE TRACK, OCEAN DUMPSITE OFF PORLIER PASS (1976).

PISCES IV DIVE RECORD

Location: Stuart Channel (Ladysmith Harbour) Date: 3 September 1976

Dive No.: 479 (Track 11) (Fig. 57)

Observers: G. Packman, N. Holman

Position:	Start	Turn	Finish
	48°57.98'N	48°58.02'N	48°57.96'N
	123°43.20'W	123°43.75'W	123°43.65'W

Depth: 84m

Location: Stuart Channel (Osborn Bay) Date: 3 September 1976

Dive No.: 480 (Track 12) (Fig. 58)

Observers: N. Holman, V. Bradshaw

Position:	Start	Turn	Turn	Finish
	48°52.38'N	48°52.38'N	48°52.65'N	48°52.39'N
	123°35.85'W	123°36.10'W	123°35.38'W	123°35.30'W

Depth: 205m

Visibility - 1.2m

Bottom Characteristics

The bottom was a typical mud bottom however a rock face was located with the side scan sonar and inspected. A bacterial slime over the mud was noted in some areas.

Benthic Fauna

The water column just above the bottom was extremely densely populated with Euphausids throughout the dive.

Mud Bottom

The actual benthic fauna appeared to be mainly epibenthic as few holes or burrows in the mud were observed. However burrowing anemones (Pachycerianthus sp) were apparent, but sparse.

The epifauna observed included crangon, pink shrimp (*Pandalus borealis*), Dungeness crabs (*Cancer magister*), eelpouts (Zoarcidae), sole (Pleuronectidae), grey cod (*Gadus macrocephalus*) and pricklebacks (*Stichaeidae*).

Rock Face

The rock face was heavily populated with fish as well as sedentary invertebrates. Some groups represented included sea anemones of a variety of species including *Metriduim senile*, sea cucumbers (*Parastichopus californicus*), starfish such as *Mediaster aequalis* and *Pycnopodia helianthoides*, prawns (*Pandalus platyceros*), squat lobsters (*Munida quadraspina*), spider crabs (*Oregonia gracilis*), a number of rock fish (*Sebastes alutus* and *Sebastes maliger*) and lingcod (*Ophiodon elogatus*).

Summary

The major aspects of this area worth noting were the relatively heavy populations of bathypelagic euphausids throughout and the fish populations especially rock fish and lingcod in the vicinity of the rocky area.

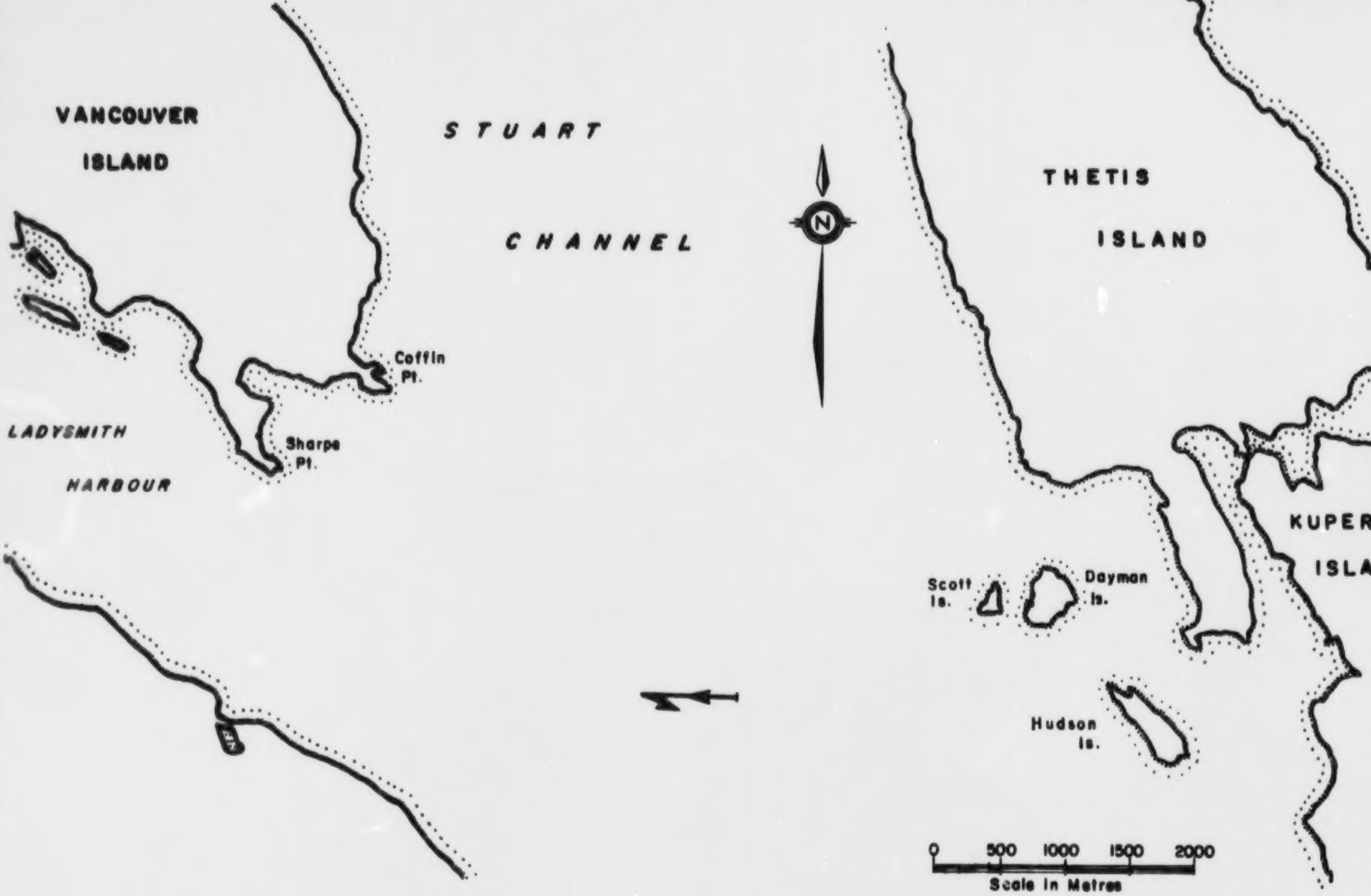
VANCOUVER
ISLAND
STUART
CHANNEL
THETIS
ISLAND
KUPER
ISLAND
Coffin Pt.
Sharpe Pt.
LADYSMITH
HARBOUR
N
Scott Is.
Dayman Is.
Hudson Is.
0
500
1000
1500
2000
Scale in Metres

FIG. 57 PISCES DIVE TRACK, STUART CHANNEL DUMPSITE (1976).

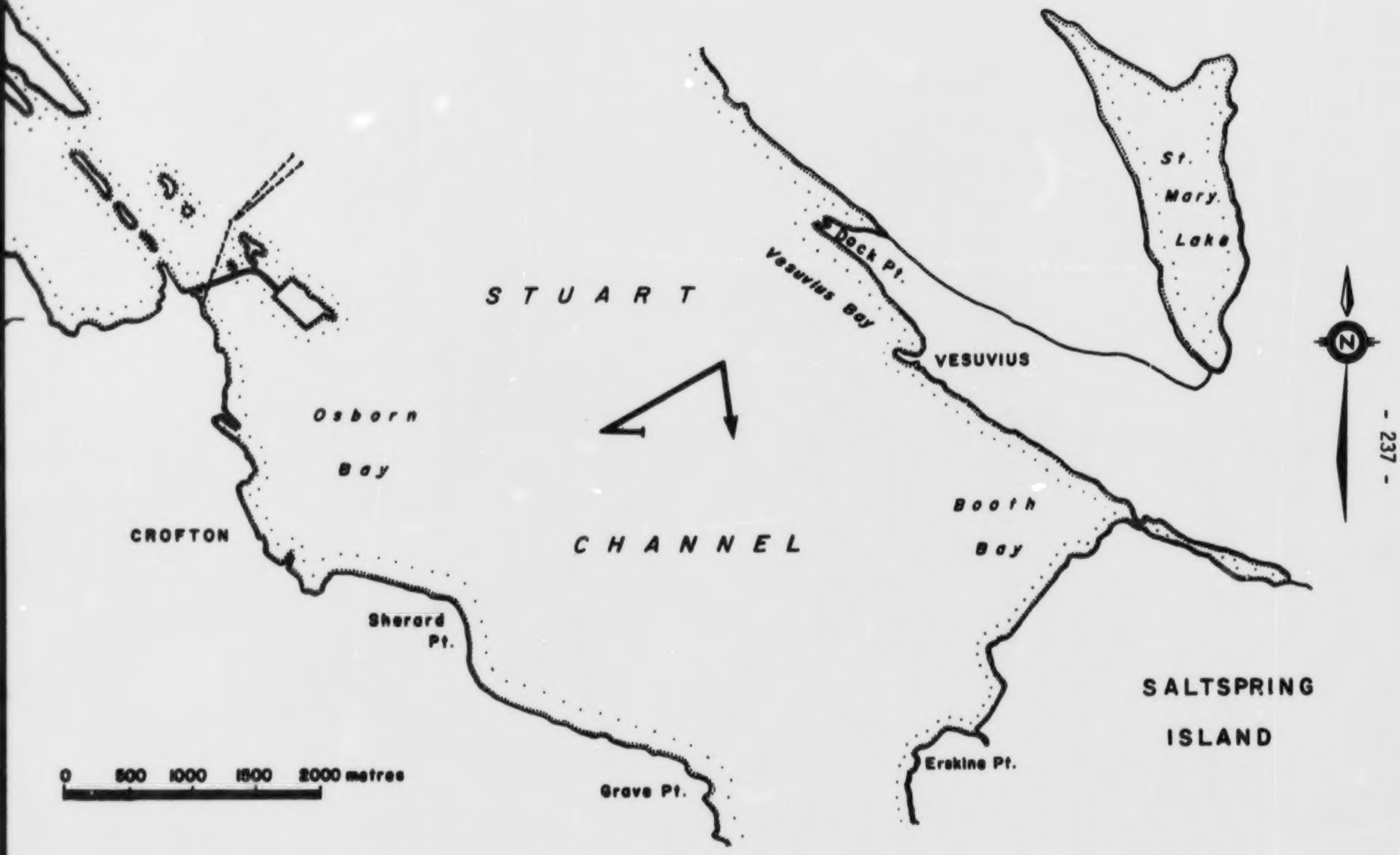
St. Mary Lake
Dock Pt.
Vesuvius Bay
VESUVIUS
STUART
CHANNEL
Osborn
Bay
CROFTON
Booth
Bay
Sherard
Pt.
Grave Pt.
Erskine Pt.
SALTSPRING
ISLAND
N
0
500
1000
1500
2000 metres

FIG. 58 PISCES DIVE TRACK, STUART CHANNEL (OSBORN BAY) DUMPSITE (1976).

PISCES IV DIVE RECORD

Location: Saanich Inlet (centre Channel between Mill Bay and Patricia Bay) Date: 8 March 1977

Dive No.: 592 (Fig. 59)

Observers: R. Hoos, V. Bradshaw

Position:

	Start	Finish
	48°39.00'N	48°39.25'N
	123°30.90'W	123°31.00'W

Depth: 175m

OBSERVATIONS:

Descending	- 55 metres juvenile euphausids amphipods - *Cyphocaris*, *Parathemisto*
75m	- Dense plankton layer
120m	- Detritus and *Orchomenella* only in water column
170m	- On bottom
Bottom	- settled into bottom. Visibility good. Amphipods feeding on greeny gray surface sediment. Black underneath. - Sank 1m into soft substrate. Claw burried - Some rippling of bottom upon landing. But not as soft as at Ocean Falls. 1.0 to.5 km/hr current from west - *Orchomonella* feeding on detritus. Bottom uniform in appearance. Grey-green colour. A few depressions. Maple Leaf in fall colour seen. One 30 - 40 cm cod seen. - Surface at 1720 hours.

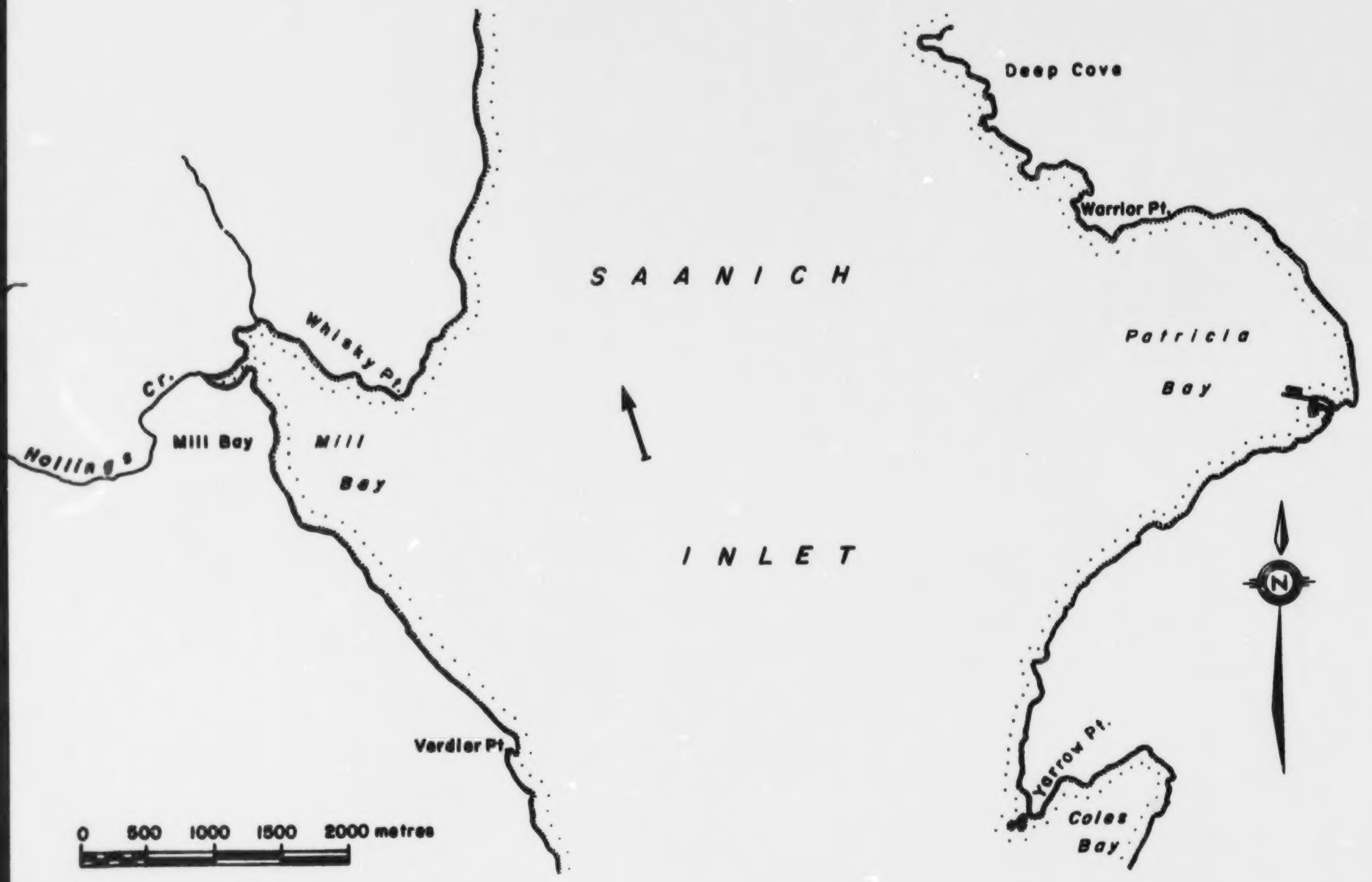
Deep Cove
Warrior Pt.
SAANICH
Patricia
Bay
Whisky Pt.
Cr.
Mill Bay
Hollings
Mill
Bay
INLET
N
Verdier Pt.
Yarrow Pt.
Coles
Bay
0
500
1000
1500
2000 metres

FIG. 59 PISCES DIVE TRACK, SAANICH INLET off MILL BAY (1977). POTENTIAL DUMPSITE

PISCES IV DIVE RECORD

Location: Alberni Inlet (Stamp Narrows Ocean Dump Site)

Date: 11 March 1977

Dive No.: 594 (Fig. 60)

Observers: R. Hoos, V. Bradshaw

Position:	Start
	49°12.10'N
	124°49.10'W

Depth: 55-60m

OBSERVATIONS:

Descending

- Fresh water interference down to 5m. PISCES was stopped at 5m by pychnocline. More ballast required.
- No plankton observed down to 55m (bottom). Herring and smelt observed on arrival at bottom.

Bottom

- Flat bottom at point of descent. Soft silt, no indication of dumping at this point. Variety of small eelpouts, poachers, small flatfish, smelts and rockfish noted.
- Cables and wires found at one point.
- Direct quote from PISCES "its just teeming with smelt down here; 100's of smelt, over".
- eelpouts approx $1/m^2$. Dominant fish outside of schools of smelt, herring.
- 10 minutes into dive and have run into some dumped material covered in fine film of sediment. Bottom is "lumpy" up to 3-4 cm above bottom. Considerable wood debris incorporated into lumps. Surface only disrupted where debris lands. Fewer shrimp in area of concentrated wood debris.
- Small logs, lots of branches, pieces of wood. Over dumpsite includes the above and some large logs. Eelpouts and a few ratfish only animals noticed in area

of concentrated dumping. While stationary, smelt were attracted to lights.

- Ran PISCES into tree trunk with complete root system. Bottom littered with wood debris. Eelpouts, a few smelt and a few small sole present.
- 1 brittlestar. No sign of shrimp, but only few were present on "unaffected" bottom.
- Near southern extremity of dumpsite, ran into large number of large logs, probably constituting fall-out from log booming area above. Bundle straps noted.
- F. Chambers quote "Dangerous area, there are a great many huge logs standing up and lying down, and I do not like this area whatsoever".
- Course changed to get away from this area. PISCES surfaced at 1617.

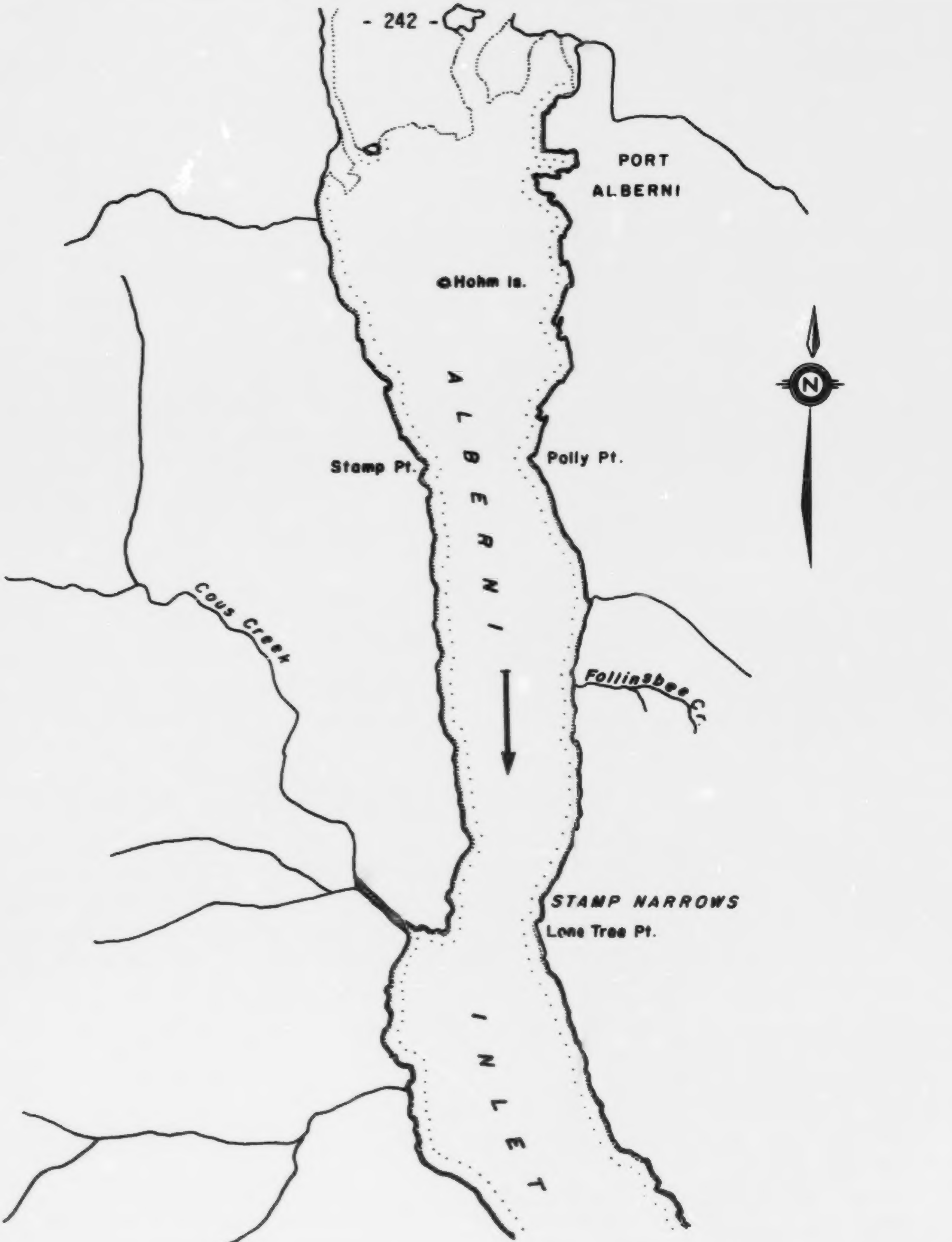
PORT
ALBERNI
Hohm Is.
ALBERNI
Stamp Pt.
Polly Pt.
Cous Creek
Follinsbee Cr.
STAMP NARROWS
Lone Tree Pt.
INLET
N
0
500
1000
1500
2000 metres

FIG. 60 PISCES DIVE TRACK, ALBERNI INLET DUMPSITE (1977).

PISCES IV DIVE RECORD

Location:	Muchalat Inlet (off Gold River pulp mill)	Date: 12 March 1977
Dive No.:	595 (Fig. 22)	
Observers:	G. Packman, H. Nelson	

Position:	Start	Finish
	49°40.25'N	49°40.60'N
	126°06.70'W	126°80.31'W

Depth: 340m

OCEANOGRAPHIC CHARACTERISTICS

Depth (m)	Temperature (°C)	Salinity %	Dissolved Oxygen (mg/l)	% Saturation (°2)
0	5.3	4.1	11.6	97.1
2	8.0	27.0	7.8	80.3
6	8.6	28.7	7.3	77.1
10	8.6	29.3	8.4	89.0
20	8.7	29.7	8.0	85.2
50	9.0	31.2	5.5	59.6
350	7.7	32.8	0.1	1.1

OBSERVATIONS:

Water Column - Initially the water column was quite brown in colour, presumably from the presence of pulp mill effluent. This discolouration extended to a depth of 10m whereupon layers of clear and discoloured water were traversed until final clearing occurred at 15 metres. Large quantities of detritus (possibly part or all fibre) were observed in the upper 25m of the water column. As the bottom was approached the water became quite milky and on the bottom the visibility was approximately 2m.

Bottom - Where the PISCES landed, the bottom was observed to consist of a flat dark brown substrate which was presumed a mixture of sediment and fibre. Beneath the dark brown surface layer a black ooze was observed which probably contained hydrogen sulphide. Some branches and logs were observed throughout the dive. They protruded from under a thick covering of detritus and probably originated as dumped material which was then rapidly covered over. The only fauna observed on the actual floor of the inlet consisted of amphipods. The amphipods disappeared as the PISCES moved closer to the mill outfall and fibre deposition became more intense.

Close to the side of the inlet in the vicinity of the outfall the bottom began to slope steeply and then became a rocky cliff at a depth of about 340 metres. Fibre was observed to have piled up considerably at the base of the rock cliff. Initially no life at all was observed on the rock, however, squat lobsters (Munida quadrispina) were soon found and at a depth of 250 metres a sea anemone (Metridium senile) was observed. Life continued to increase in abundance as the cliff was ascended, with calcareous tubiculous polychaetes and Crangonidae being added to the fauna already observed. Chitons were observed on the rocks at 220 metres. With continually decreasing depth polychaetes on the undersides of the rocks became more numerous and a grey cod (Gadus macrocephalus) was observed. At 65 metres sea anemones (Metridium senile), a nudibranch, and a ratfish (Hydrolagos colliei) were observed, while at 50 metres cup corals were present.

The diffuser from the Tahsis Gold River pulp mill was located at 20 metres. It was found to lie diagonally across the cliff face being supported by steel cables. It was constructed of steel, with ports along its length, however the end was open and most of the effluent was flowing out of that aperture.

An abundance of rockfish, ratfish and sea anemones were observed in the vicinity of the diffuser, presumably being attracted to the area by the warm effluent. A number of dying rockfish were found on the surface by the PISCES crew. These appeared to have been caught in the effluent stream and succumbed either to the toxic properties of the effluent or were suffering from ruptured gas bladders resulting from their rapid ascent in the effluent stream. Visibility in the area was limited due to the presence of effluent in the water.

Comments - The bottom in this area seemed suitable for Ocean Dumping activities as little life existed and the rapid fibre deposition appears to cover over any dumped material.

PISCES IV DIVE RECORD

Location: Muchalat Inlet
(West of Gold River Pulp Mill)

Date: 12 March 1977

Dive No.: 596 (Fig. 22)

Observers: H. Nelson, D. Sullivan

Position:

Start	Finish
49°38.90'N	49°39.10'N
126°16.20'W	126°16.20'W

Depth: 225m

OBSERVATIONS:

Decending	- small white particles in suspension
75m	- few plankters, some pelagic amphipods and siphonophores
115m	- white suspension still present, few plankters, one Pasiphaea pacifica (pelagic shrimp)
175m	- several copepods, P. pacifica (less plankton than noted on previous dive near pulp mill (595). Also the strands of particles and fine fibres (wood) not seen in this dive.)
200m	- squid
Bottom	
225m	- rock face with many Munida quadrispina (squat lobster), many brachiopods - Spirontocaris sp., rockfish, squid, sole, sponge. - Lophaster sp. (spiny starfish), anemone, spider crab
200m	- Pandalus platyceros (prawn), hairy triton, tube polychaetes (considerably more life than noted on Dive 595).

135m	- many Gorgonian corals, prawns, one box crab, hermit crabs, tunicates, rockfish.
100m	- tunicates, brachiopods, cloud sponges, urichins, many tube polychaetes. - shelves on rock face have substrate of sand and shell fragments
75m	- _Pachycerianthus_ sp. (burrowing anemone) - abundant brachiopods and tube polychaetes covering rock faces
50m	- several burrowing anemones
20m	- begin ascent.

SUMMARY

Differences noted from dive (595) off the Gold River pulp mill include less fibre and fewer strands of particulate matter in water column. Plankton in water column less abundant however benthic life significantly more abundant. Of particular interest, the large gorgonian corals at 135 metres.

PISCES IV DIVE RECORD

Location: Zeballos Inlet   Date: 14 March 1977

Dive No.: 599 (Track 16) (Fig. 61)

Observers: D. Sullivan, G. Packman

Position:

Start	Finish
49°55.30'N	49°55.30.N
126°50.09'W	126°50.07'W

Depth 110m

OCEANOGRAPHIC CHARACTERISTICS

Depth	Temperature	Salinity	D.O.	% Saturation
0	7.68	15.94	10.55	100.4
2	8.55	26.9	8.85	92.19
5	8.68	28.61	8.85	93.50
10	8.68	29.24	8.25	87.55
25	9.27	29.88	6.4	69.15
105	8.86	30.5	1.2	12.90

OBSERVATIONS:

Watercolumn

The watercolumn was generally very clean with little in the way of phytoplankton, zooplankton or detritus. Light was observed to extend to a depth of approximately 50m. A zooplankton layer composed mainly of pelagic amphipods and copepods was found just above the bottom at 105m.

Bottom

The bottom in the immediate area of descent was composed of a soft mud substrate penetrated by a number of deep holes. Many polychaete castings were also observed on the surface of the sediments. As the dive progressed some wood debris was observed as well as an area of gravel and rock debris. This debris appeared to have been the result of dumping activities and extended for a distance of 45-90m. Towards the end of the dive a rocky cliff was ascended.

Fauna

A rich faunal composition was observed throughout the dive. The fauna observed on the mud substrate included squat lobsters (Munida quadrispina) in concentrations of 2-3/m^2, some prawns (Pandalus platyceros), pink shrimp, grey cod (Gadus macrocephalus), poachers (Agonidae), pricklebacks (Stichaeidae), eelpouts (Zoarcidae), catfish (Hydrolagus colliei), and numerous small sole (Pleuronectidae). The composition of the community changed somewhat in the area where gravel had been deposited on the bottom. In these areas there was a definite lack of infaunal animals, however the concentration of epifauna such as pink shrimp and squat lobsters were not greatly reduced.

Towards the end of the dive, a steep mud slope and rock cliff were ascended. Fauna observed in these areas included burrowing sea anemones (Pachycerianthus sp.), prawns (Pandalus platyceros) and rockfish (Scorpaenidae). There appeared to be no effect resulting from dumping activities in this area.

Comments

The effects of ocean dumping observed on this dive were limited to the deposition of gravel and rock debris in a concentrated area in the middle of the inlet. It appeared as though the infaunal communities were destroyed in this area, however the epifaunal communities were not greatly affected. With the deposition of sediment in the future, infaunal communities should return to the area.

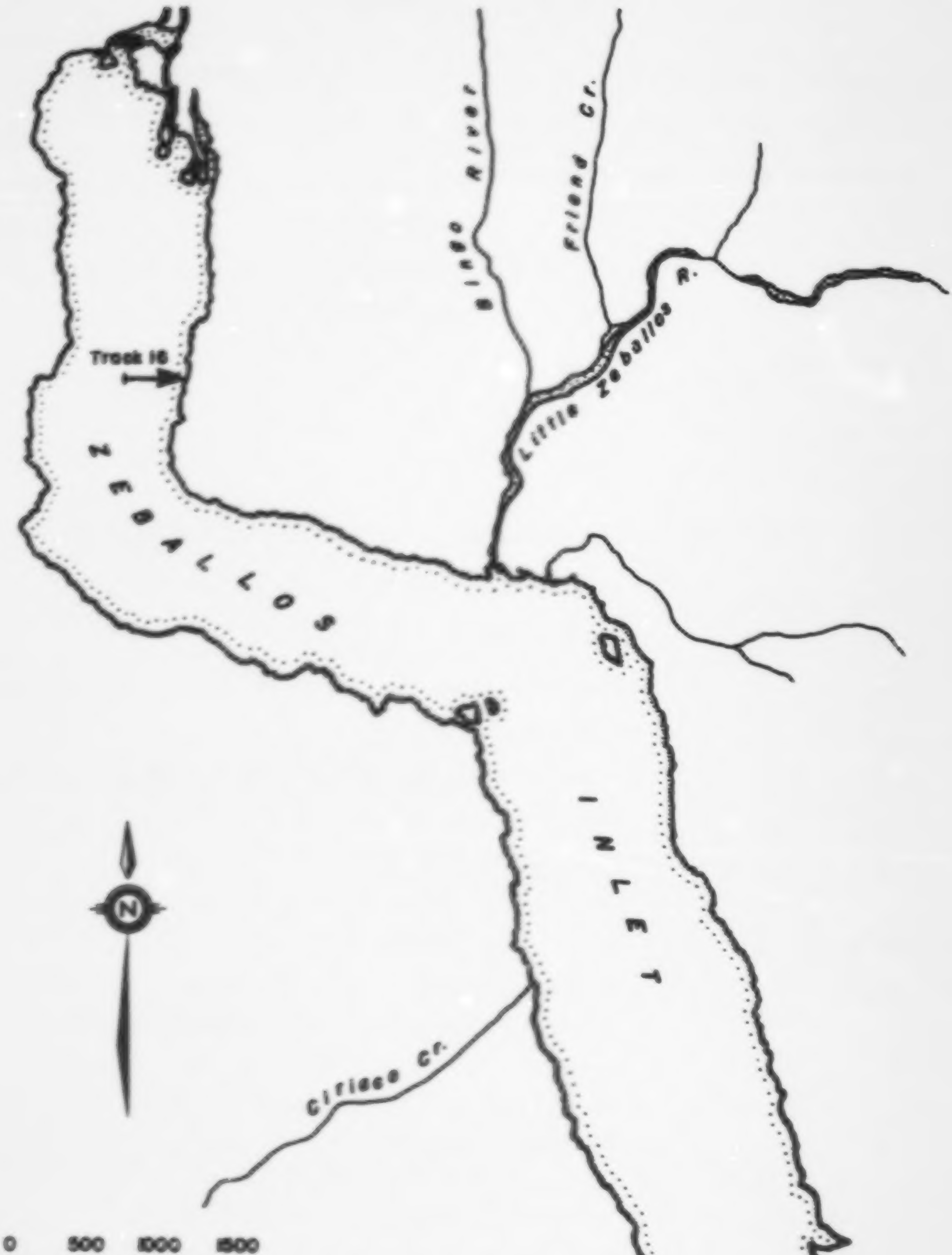
Track 16
ZEBALLOS
INLET
Bingo River
Friend Cr.
Little Zeballos R.
Cirlaca Cr.
N
0 500 1000 1500
Scale in Metres

FIG.61 PISCES DIVE TRACK, ZEBALLOS INLET DUMPSITE (1977).

PISCES IV DIVE RECORD

Location: Zeballos Inlet   Date: 14 March 1977

Dive No.: 600 (Track 17) (Fig. 62)

Observers: D. Sullivan, H. Nelson

Position:

	Start	Finish
	49°57.20'N	49°56.97'N
	127°49.96'W	127°49.92'W

Depth: 165m

OBSERVATIONS:

Descending

25m - visibility good, small particles, no plankton

50m - no plankton

75m - few copepods

90m - several zooplankters including euphausids, amphipods, copepods

125m - siphonophores, pelagic ampipods Pasiphaea pacifica, copepods

150m - Pasiphaea pacifica

Bottom

165m
- bottom topography, - rolling mounds
- substrate fine soft sediment pocked with craters with diameters 2.5 cm to several cm.
- several Bolinopsis sp. just off bottom
- few Munida quadrispina
- slight current from 210°
- many small copepods just off bottom
- small sole, shrimp, eel pout, Bolinopsis sp., prickleback, ratfish, rock fish
- very little wood debris

- white legged shrimp

165m - begin up mud slope, no indication of dumping activity
- bottom current increased, now from 300°
- close to shore, turned and headed back out into inlet
- few Munida and shrimp
- *Metridium* sp. on log, prawn *Pandalus platyceros*
- up slope on south shore - prickleback, sturgeon poacher, *Pachycerianthes* sp. (burrowing anemone)
- more wood debris
- large logs, small rockfish (school)

40m - much surface light

Ascent

SUMMARY

Despite the fact that we were supposedly diving in an ocean dumping area the logs and wood debris encountered on the south shore appeared to be of natural origin. Visibility was very good in the area and benthic life observed would be expected in an unpolluted area of similar substrate type.

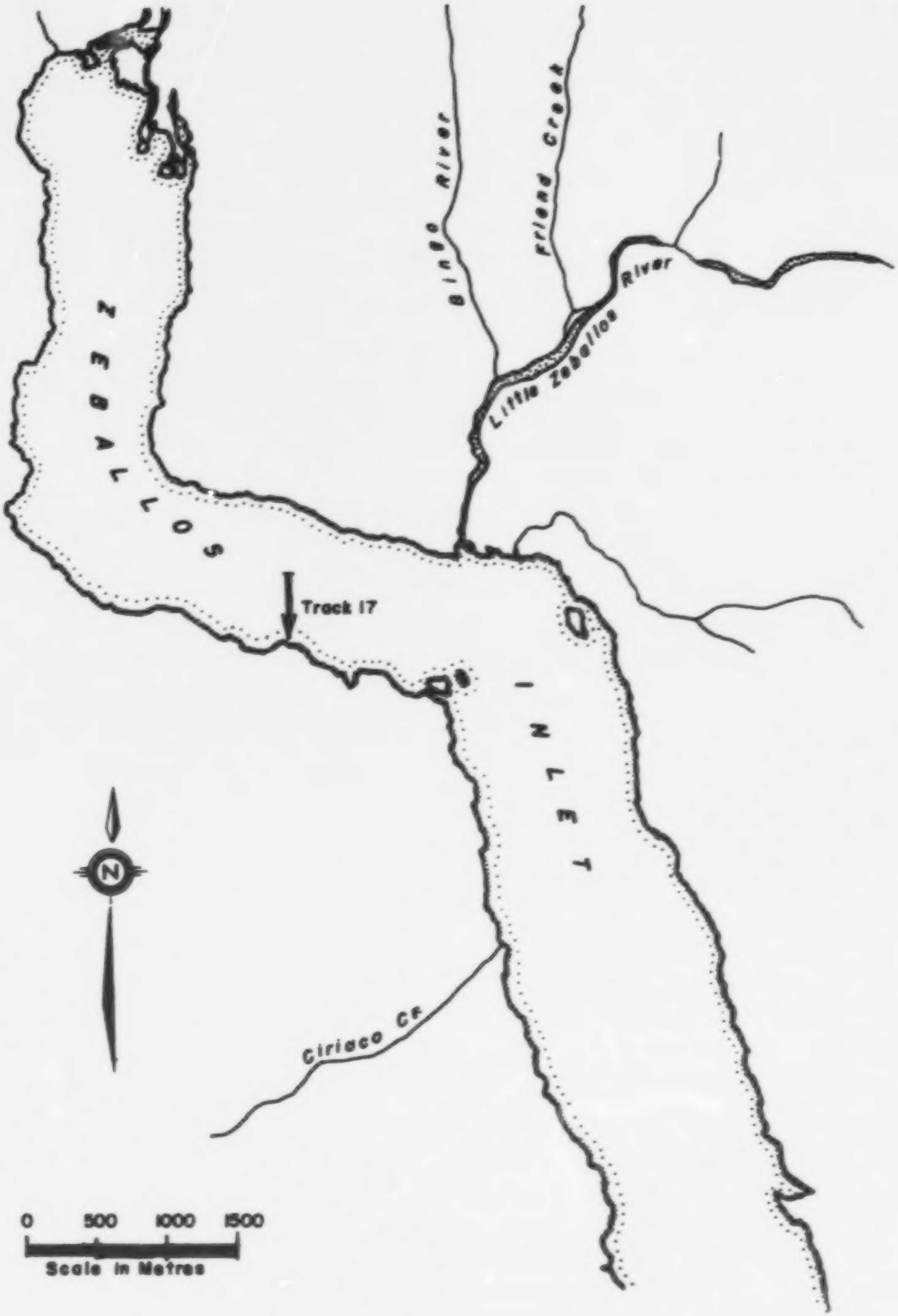
ZEBALLOS
INLET
Track 17
Bingo River
Friend Creek
Little Zeballos River
Ciriaco Cr.
N
0
500
1000
1500
Scale in Metres

FIG.62 PISCES DIVE TRACK, ZEBALLOS INLET DUMPSITE (1977).

PISCES IV DIVE RECORD

Location: Quatsino Sound
(East of Koskimo Island)

Date: 15 March 1977

Dive No.: 601 (Fig. 63)

Observers: D. Sullivan, H. Nelson

Position:	Start	Finish
	50°28.5'N	50°29.2'N
	127°50.0'W	127°50.2'W

Depth: 190m

OBSERVATIONS:

Descending	- surface visibility fair - no plankters in water column
100m	- euphausids, *Pasiphaea pacifica*, pelagic amphipods - fairly large particles in suspension, visibility good - no significant increase in plankton
Bottom	
150m	- soft mud, a few craters but not as numerous as the dive off Zeballos - bottom covered with Ophiuroids, single *Pandalus platylceros*, 1 *Hydrolagus colliei* - several mud casts, pink shrimp, white banded legs, sole - heading off on course due north
165m	- dipping in hole, *Pseudarcaster* sp., number of Ophiuroids increasing, so abundant their arms are overlapping - side-stripe *Pandalopsus dispar*
180m	- sea whip (30 cm.), large sole, hairy triton *Fusitritoin* sp., hermit crab
190m	- substrate unchanged, bottom still covered with brittle stars - prawn, several small rat fish

185m	- approximately mid channel, sponge - visibility decreased to approximately 3m, water murky - number of craters decreasing, sea urchin, side-stripe, large sole, sponge, Pseudarcaster sp., many small shrimp - substrate becoming more rocky, many small bivalves, believed to be juvenile scallops - nudibranch, cushion star, anemone 170m - several rat fish
165m	- many scallops, polychaete tubes - sediment soft with surface layer of coarse sand or gravel, several Pseudarcaster sp.
150m	- working up north slope, most dominant organism still the brittle star, with many small bivalves - yellow encrusting sponge, tunicates - slope increasing, clump of Metridium sp., large boulders - several Parasticopus sp. and Strongylocentrotus sp. - large halibut (14-20 kgs)
155m	- number of Ophiuroids decreased
150m	- back to soft mud substrate with a few rocks - large sole
165m	- heading up incline again, shrimp, larger brittle stars
140m	- not many organisms on mud slope
130m	- eel pout, few brittle stars, spiny pinks
125m	- large shark (1-1.25m)
115m	- many zooplankters, mostly euphausiids
100m	- 1st Munida sp.
75m	- large rocks and boulders, cloud sponge
50m	- begin ascent

SUMMARY

As a control site, there appeared to be more sediment than was expected. The entire bottom surface was covered with brownish sediment. The visibility was correspondingly reduced. The location was nowhere as productive as expected. Dive aborted - damage to port thruster.

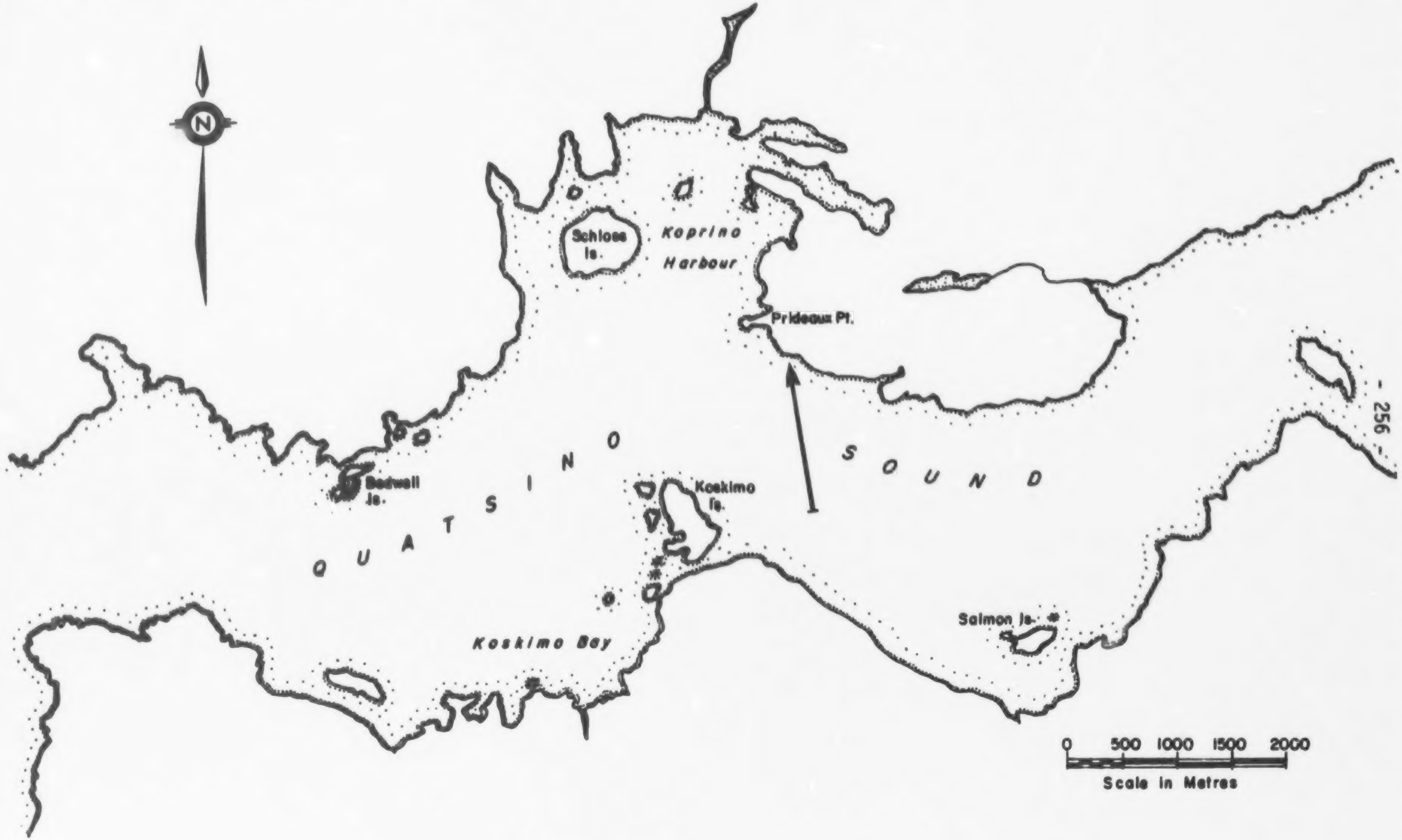
N
Schloss Is.
Koprino Harbour
Prideaux Pt.
Q U A T S I N O
S O U N D
Bedwell Is.
Koskimo Is.
Koskimo Bay
Salmon Is.
0 500 1000 1500 2000
Scale in Metres

FIG. 63 PISCES DIVE TRACK, QUATSINO SOUND OCEAN DUMPSITE (1977).

PISCES IV DIVE RECORD

Location: Five Finger Island Site (Nanaimo Ocean Dumpsite)

Date: 14 April 1978

Dive No.: 650 (Fig. 64)

Observers: D. Sullivan, D. Brothers

Position:	Start	Finish
	$49^{o}14.4'$N	$49^{o}15.25'$N
	$124^{o}53.9'$W	$124^{o}53.30'$W

Depth: 260m

WATERCOLUMN

Water clarity during descent was estimated at between 5-7 metres visibility. Visual light penetration extended to approximately 80 metres. Suspended detrital material was present throughout the watercolumn in concentrations considered "normal". Bottom was reached at 260 metres depth; water clarity remained the same.

Zooplankton concentrations were sparce to 80 metres, heavy from 80-100 metres (predominantly euphausids), and moderate from 100 metres to the bottom. Zooplankton observed included ctenophores (heaviest at 170 metres), amphipods, free swimming polychaetes, and decapod larvae. Two hake (*Merluccius productus*) were observed at 220 metres depth and many *Pasiphaea pacifica* were noted near the bottom.

Bottom Characteristics & Dive Track

After reaching bottom, "PISCES" proceeded on a slightly descending grade on course 010^{o} magnetic at 1436 hours P.S.T. During this portion of the track, the bottom was predominantly sediment with some rock outcroppings. The sediment consisted of a fine brownish layer overlying a grey clay-like substrate. A .5 km/hr to 1.0 km/hr current was setting against "PISCES" during this portion of the track.

At 1457 hours P.S.T. and 270 metre depth, a rock cliff was encountered. "PISCES" ascended the cliff face to 223 metres. The sediment encountered at this point was similar to that at the cliff bottom, but with a notable amount of cobble. The current at this point had increased to an estimated 1.5 km/hr.

At 1503 hours proceeding on course 010° magnetic, "PISCES" ascended a gradual incline to 207 metres and descended a gradual decline to 280 metres, at which point the bottom became level.

At 1628 hours, "PISCES" began ascent and surfaced. No dumped material was encountered during the dive.

Biota Observed

Epifauna and infauna was sparce on the sediments, but quite prolific on and in the vicinity of rock faces. Burrowing activity was limited; about one burrow per square metre at most.

Table 1 gives the relative abundance of the biota observed during the dive.

Table 1

	TAXON	
HYALOSPONGIA	*Aphrocallistes* sp.	many
	Rhabdocalyptus sp.	many
ANTHOZOA	*Pachycerianthus* sp.	many
	Paragorgia arborea	few
CRUSTACEA	*Pasiphaea pacifica*	many
	Pandalopsis dispar	many
	Pandalus spp.	many
	P. platyceros	common
	Munida quadrispina	few
	Paguridae	few
	Lithodidae	noted
BRYOZOA		many
BRACHIOPODA		many
OPHIUROIDEA		many
ASTEROIDEA	*Ctenodiscus chispatus*	many
	Asteroidea (unidentified)	

Table 1 (continued)

PISCES	Squalus acanthias	few
	Hydrolagus colliei	common
	H. colliei (egg cases)	noted
	Gadus macrocephalus	noted
	Sebastolobus alascanus	common
	Lycodopsis pacifica	noted
	Pleuronectidae	common
	Agonidae	noted

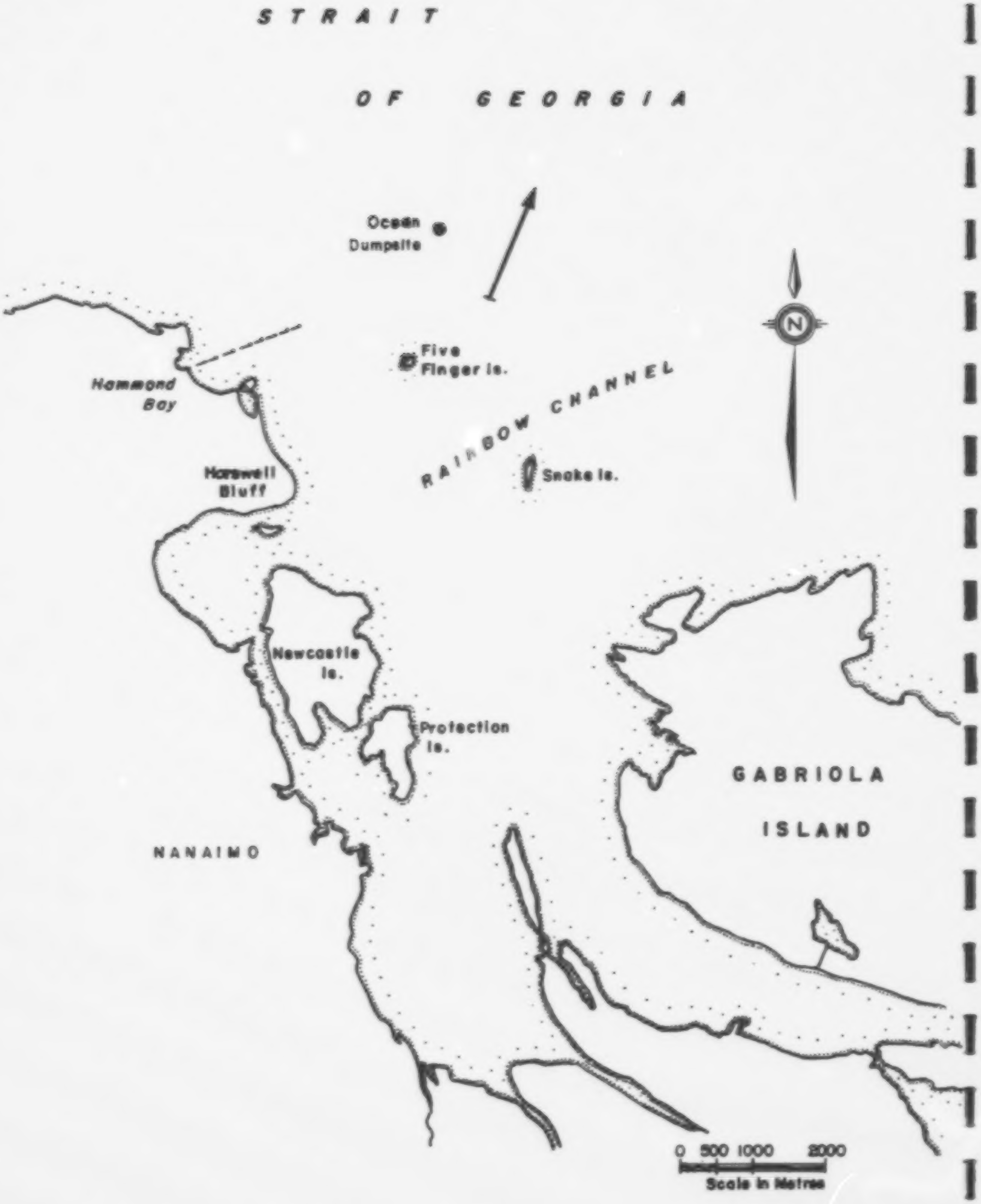
STRAIT
OF GEORGIA
Ocean Dumpsite
Five Finger Is.
RAINBOW CHANNEL
Snake Is.
Hammond Bay
Horswell Bluff
Newcastle Is.
Protection Is.
NANAIMO
GABRIOLA ISLAND
N
0 500 1000 2000
Scale in Metres

FIG.64 PISCES DIVE TRACK, NANAIMO DUMPSITE (1978).

PISCES IV DIVE RECORD

Location: Point Grey

Date: 27 November 1978

Dive No.: 714 (Track 1) (Fig. 49)

Observers: G. Packman, N. Holman

Position:

	Start	Finish
	$49^{0}16.11$'N	$49^{0}16.19$'N
	$123^{0}21.03$'W	$123^{0}21.48$'W

Depth: 240m

Water Column

On descent the water column was fairly clear with good visibility down to a depth of approximately 60 metres. Between 70 metres and 80 metres a zooplankton layer was encountered. The predominant zooplankters in this layer were pelagic amphipods and euphausids. At approximately 80m this layer cleared somewhat while the concentration of detrital material increased. From 80m to the bottom at 240m the concentration of detrital material continued to increase while the concentration of zooplankton remained minimal. At 120m a number of chaetognaths were encountered. As well a few pelagic fish resembling smelt were observed during the descent. Near the bottom the visibility dropped markedly due to the presence of detrital material, which may have been stirred up from the bottom by the relatively strong bottom currents in the Point Grey area. Pelagic Shrimp (Pasiphaea pacifica) were observed near the bottom. The characteristics of the water column were similar on ascent.

Table 1 below depicts the readings obtained from the CTD probes on the exterior of the boat. Although the values obtained by the CTD had not at that time been compared with values obtained by more traditional methods, they were stable and of the same order of magnitude as would be expected. Therefore, it has been assumed that these values are reasonably accurate, especially in light of the fact that the instrument had just been serviced by the manufacturer.

TABLE 1 CTD READINGS

Depth	Temperature (^{0}C)	Conductivity (m mhos/cm)	Dissolved Oxygen (mg/l)
140m	8.4	32.65	7.88
186m	8.58	32.92	7.73
227m	8.7	33.25	7.0
239m (bottom)	8.65	33.25	6.13
240m (bottom)	8.6	33.23	6.3
167m	8.4	32.72	7.1
157m	8.4	32.69	7.26

Bottom Characteristics

The bottom characteristics were fairly constant throughout the dive with the dominant characteristic being a layer of woodwaste intermingled with and lying on top of the normally soft Point Grey sediments. Clumps or piles of bark and wood debris were observed regularly as though they had remained intact through the water column after being dumped off the barge. Also apparent in some locations were patches containing various combinations of broken granite, gravel and hardpan clay. In some areas the bottom felt quite solid under the PISCES and little sediment was stirred up by the boat. This was felt to be due to the packing down of wood debris over the normally fine Strait of Georgia sediments. Numerous logs were observed on the bottom as well as other anthropogenic items, such as pieces of steel cable, a piece of sheet metal and a plastic container. The number of holes in the bottom, from benthic infaunal burrowing, was felt to have been reduced from what would be termed "normal" in the Strait of Georgia. In general it was felt that the bottom was significantly disturbed from the natural situation.

Bottom Fauna

A list of the fauna observed as well as an indication of abundance is presented in Table 2. The dominant impression of the dive was that the bottom dwelling animals were not very abundant. A concerted attempt was made to count every animal in the field of view with the exception of the Nemerteans, which were too abundant. Therefore, although some animals may have been missed in the counting process, the numbers in the "abundance" column are fairly accurate and give an indication of the low level of abundance.

Woodwastes appeared to have covered the bottom and this might be correlated with the small number of holes in the bottom from benthic infauna. It should be pointed out, however, that the abundant orange nemerteans were associated with woodwastes approximately 70% of the time. The anemones observed were associated with logs etc., exclusively, while the shrimp and rock fish (Sebastolobus alascanus) were often found near logs and clumps of debris. The gastropod Neptunea sp. was found almost exclusively on sunken logs.

TABLE 2 FAUNAL LIST

Taxon	Abundance
Nemertea	One of the most numerous faunal forms, often located on a piece of wood protruding from the bottom
Actinaria	
Unidentified	2 - throughout dive
Unidentified: (orange with white spots on column)	3 - throughout dive
Pachycerianthus sp.	3 - throughout dive
Gastropoda	
Unidentified	1 - throughout dive
Nudibranch (unidentified)	1 - throughout dive
Neptunea sp.	13- throughout dive; mainly on logs
Echinoidea	
Unidentified	2

Taxon	Abundance
Ateroidea	
Ctenodiscus sp.	4
Mediaster sp.	3
Crustacea	
Pasiphaea pacifica	present in water column just above bottom
Pandalopsis dispar (side stripe shrimp)	29 - throughout dive
Pandalus platyceros	3 - throughout dive
Unidentified pink shrimp	19 - throughout dive
Munida quadrispina	2 - throughout dive
Spider crab (unidentified)	1 - throughout dive
Pisces	
Squalus acanthias (juvenile dogfish)	4 - throughout dive
Hydrolagus colliei (ratfish)	3 - throughout dive
Microgradus proximus (tomcodi)	1 - throughout dive
Zoarcidae	3 - throughout dive
Sebastolobus alascanus (short spine thornyhead)	9 - throughout dive
Pleuronectidae	2 - throughout dive

Conclusions

Evidence of dumped material was apparent throughout the dive. The most surprising observation made in the course of the dive was that wood and bark debris had travelled through the water column and landed on the bottom in remarkably large clumps and aggregations. It has previously been assumed that this type of material would disperse before it hit the bottom. The general impression derived from the dive was that the benthic epifauna and infauna had been reduced somewhat by the presence of dumped wood debris, however, this was only a qualitative impression.

PISCES IV DIVE RECORD

Location: Point Grey Date: 28 November 1978

Dive No.: 715 (Track 2) (Fig. 49)

Observers: G. Packman, D. Brothers

Position:	Start	Finish
	$49^{0}15.25'$N	$49^{0}16.03'$N
	$123^{0}21.03'$W	$123^{0}21.60'$W

Depth: 246m

Water Column

On descent the water column was fairly clear with good visibility down to a depth of approximately 80 metres. Between 90 metres and 130 metres a zooplankton layer was encountered. Zooplankton observed in this layer included ctenophores, pelagic amphipods, euphausids, some decapod larvae and the occasional smelt-like fish. Slightly below the defined zooplankton layer, at about 150 metres, some Chaetognaths and Siphonophores were observed. Below the zooplankton layer the concentration of detrital material became thicker to the point where visibility was reduced to approximately 2.3m near the bottom. The depth at the bottom was 240 metres. On ascent surface light was first observed at approximately the 100 metre depth.

Table 1 presents the observations of depth, temperature, conductivity and dissolved oxygen obtained with the CTD probes outside the PISCES.

TABLE 1 CTD READINGS

Depth	Temperature (^{o}C)	Conductivity (m mhos/cm)	Dissolved Oxygen (mg/l)
0m	6.6	26.62	11.1
84m	8.6	32.5	8.1
133m	8.5	32.6	8.2
200m	8.5	33.0	7.9
240m (bottom)	8.55	33.17	6.4
246m (bottom)	8.5	33.18	6.43
244m (bottom)	8.5	33.2	6.6
221m	8.5	33.1	6.4
194m	8.5	33.1	6.4
115m	8.9	33.1	6.6
100m	8.5	32.5	6.8
65m	9.2	33.0	6.2
29m	9.4	32.8	5.1
18m	9.3	31.9	5.8

Bottom Characteristics

The bottom characteristics were observed to be a light mud with a fair bit of wood waste and construction material mixed in. Patches of gravel, logs and clumps of wood debris were observed at intervals through the dive. The clumps or piles of wood debris increased in frequency towards the end of the track. This was not surprising as the end of Track 2 was in close proximity to the end of Track 1 where these were observed. On occasion the bottom felt very firm under the skids of the PISCES, indicating that the normally soft sediments may have been strengthened with dumped material. Two unusual items observed during the dive were a piece of chain with a rope attached and a piece of scrap metal.

It generally appeared as though there were few holes in the bottom from infaunal burrowing. The presence of infaunal burrowers may have been reduced by dumping activities.

Bottom Fauna

The bottom fauna was generally sparse, having a fairly uniform composition throughout the dive. A list of the fauna noted is presented in Table 2. The dominant feature noted in the dive was the apparent lack of infaunal burrowing organisms. This was assumed to be associated with the changed bottom sediments stemming from ocean dumping activities. Organisms such as Neptunea sp., the unidentified orange anemone with white spots on the trunk, pink shrimp and Sebastolobus alascanus (short spine thornyhead) were often observed in association with logs or wood debris which appeared to have been there for a period of time.

It should be noted that, although there existed a fair proportion of wood waste in the sediments, there was no corresponding reduction in dissolved oxygen concentration as measured by the CTD unit on the exterior of the PISCES.

Conclusions

The bottom characteristics noted in Track 2 were very similar to those noted in Track 1, which was not surprising as they were located very close to each other. Dumped material was quite evident throughout the dive. Towards the end of the dive wood wastes were noted in piles as though they had remained intact throughout the water column after being dumped from the barge. The benthic infauna appeared to be relatively sparse. Shrimp were often found in association with sunken logs but not exclusively. Dumped material appeared to be having a qualitative impact upon the bottom characteristics.

TABLE 2 FAUNAL LIST

Taxon		Relative abundance on a scale 1-10
Nemertea		10
Actinaria	- Pachycerianthus sp.	5
	- unidentified - orange with white spots on trunk	7
	- unidentified	2
Gastropoda	- Neptunea sp.	5 abundant on logs
	- unidentified	1

Taxon		Relative abundance on a scale 1-10
Asteroidea	- Mediaster sp.	4
	- Ctenodiscus sp.	4
Crustacea	- Pasiphea pacifica	3
	- Pandalopsis dispar	7
	- unidentified pink shrimp	5
	- Munida quadrispina	1
	- Crangon sp.	1
Pisces	- Hydrolagus colliei	3
	- Squalus acanthias (juvenile)	1
	- Herring type	1
	- Zoarcidae	1
	- Sebastolobus alascanus	5
	- Pleuronectidae	2

PISCES IV DIVE RECORD

Location: Point Grey Date: 28 November 1978

Dive No.: 716 (Track 3) (Fig. 49)

Observers: G. Packman, D. Brothers

Position:	Start	Turn	Finish
	49°14.64'N 123°22.28'W	49°14.80'N 123°22.35'W	49°15.10'N 123°22.20'W

Depth: 250m

Water Column

From the surface to a depth of approximately 85 metres the water column was fairly clear with not much plankton and not much detritus. At 85 metres a zooplankton layer began, being composed mainly of pelagic amphipods, chaetognaths and euphausids. This zooplankton layer extended to approximately 130 metres. At 100 metres six dogfish (Squalus acanthias) were observed swimming around the boat, while at 120 metres a fish, which appeared to be a smelt, was observed. At 140 metres and 200 metres some small smelt-like fish, a few decapod larvae, some juvenile squid and siphonophores were observed.

As the bottom was approached the amount of detritus in the water column increased such that at the bottom (250 metres) the visibility was in the order of 1.7m. A current at a rate of approximately 1 km/hr was present on the bottom.

TABLE 1 CTD OBSERVATIONS

Depth	Temperature (°C)	Conductivity (m mhos/cm)	Dissolved Oxygen (mg/l)
25m	9.1	32.16	9.9 (may be suspect)
90m	8.9	32.8	7.8
123m	8.6	32.8	8.1
140m	8.7	32.9	7.9
175m	8.6	33.0	7.8
250m (bottom)	8.4	33.0	7.0
248m (bottom	6.85	33.16	6.85

Bottom Characteristics

The bottom throughout Track 3 was a soft mud bottom typical of the Strait of Georgia. The occasional bit of woodwaste and hardpan clay was observed but not in nearly the same quantities as observed on Tracks 1 and 2. Logs were also noted intermittently, some of which were covered with sediment. Throughout the dive the number of infaunal holes in the sediment was approximately 5 per square metre. One of the prime reasons for diving at this location was to attempt to observe a number of concrete pipes which had been dumped two years previously. One of these pipes was located and inspected. It was protruding from the mud at approximately a 20 degree angle and buried in the mud for approximately 2/3 of its length. It was covered with a light dusting of silt and detritus.

Bottom Fauna

The bottom fauna observed on Track 3 was felt to be typical of a soft mud bottom in the Strait of Georgia. The taxa noted on this track are listed in Table 2. The fauna was evenly distributed throughout the dive with the number of holes from benthic infauna being of the order of 5 per square metre. The predominant epifaunal forms were nemerteans, burrowing anemones (*Pachycerianthus* sp.) unidentified orange anemones with white spots on the column, *Mediaster* sp., sidestripe shrimp (*Pandalopsis dispar*), unidentified pink shrimp and the short-spine thornyhead rockfish (*Sebastolobus alascanus*).

Very little fauna was noted associated with the concrete pipe. The total life associated with the pipe was an unidentified orange anemone with white spots on the trunk, two *Neptunea* sp., one *Neptunea* sp. egg mass, one *Munida quadrispina*, two unidentified pink shrimp, one *Sebastolobus alasacanus* and a grey cod (*Gadus macrocephalus*).

Conclusions

The bottom throughout the dive was relatively unaffected by dumped material, indicating that this portion of the dumpsite is not used very frequently. The concrete pipes had not been extensively colonized since their deposition two years ago. Generally speaking, there did not appear to be a high degree of biological productivity in the form of epifauna in this area.

TABLE 2

FAUNAL LIST

Taxon		Abundance
Nemertea		- fairly common throughout dive
Actinaria	- unidentified- orange with trunk with white spots	- fairly common throughout dive - mainly on logs, some of soft sediment
	- *Pachycerianthus* sp.	- fairly common throughout dive
Gastropoda	- *Neptunea* sp.	- present on most logs and occasionally on soft substrate
	- Nudibranchia	- 2 noted during dive
Asteroidea	- *Mediaster* sp.	- fairly common throughout dive
Crustacea	- *Pasiphea pacifica*	- occasionally noted
	Pandalopsis dispar	- most common animal
	Pandalus platyceros	- 1 noted
	unidentified pink shrimp	- second most common faunal form
	Crangon sp.	- fairly common throughout dive
	Pagurus sp.	- 2 noted
	Tanner Crab	- 1 noted
Pisces	- *Hydrolagus colliei*	- 1 noted
	Squalus acanthias	- 1 noted
	Gadus macrocephalus	- 2 noted
	Zoarcidae	- 3 noted
	Sebastolobus alascanus	- 3 noted
	Anoplopoma fimbria	- 1 noted
	Pleuronectidae	- 2 noted

PISCES IV DIVE RECORD

Location:	Point Grey	Date: 29 November 1978
Dive No.:	718 (Track 4) (Fig. 49)	
Observers:	G. Packman, N. Holman	

Position:	Start	Finish
	49°16.50'N	49°17.18'N
	123°19.38'W	123°20.47'W

Depth: 160m

Water Column

On descent through the water column the visibility was good to a depth of about 80 metres. Up to that depth very little zooplankton or detritus was apparent other than a few copepods noted at 50 metres. A fish approximately 24 cm. in length, which was presumed to be a smelt, was noted at approximately 60 metres.

At 90 metres a zooplankton layer was encountered which contained pelagic amphipods, euphausids, the occasional decapod larva, as well as a few smelts. At 130 metres the zooplankton layer was noted to have thinned out considerably while the concentration of detritus increased and continued to increase until the bottom was reached. Pelagic shrimp (Pasiphaea pacifica) were observed from 150 metres down to the bottom at 160 metres.

TABLE 1 CTD OBSERVATIONS

Depth	Temperature (°C)	Conductivity (m mhos/cm)	Dissolved Oxygen (mg/l)
Surface	7.5	28.7	11.6
10m	8.2	30.47	11.38
40m	9.6	33.1	7.2
57m	9.6	33.2	6.8
90m	8.5	33.5	8.4
150m	8.5	32.9	8.0
160m (bottom)	8.46	32.9	7.7
158m (bottom)	8.46	32.9	7.7

Bottom Characteristics

The substrate at Track 4 was generally a sandy material with a considerable quantity of woodwaste mixed in. The woodwastes occasionally occurred in piles as though dumped from a barge, remaining intact through the water column. Other material observed on the bottom included an occasional log, pieces of cable, a tire and pieces of concrete. Very few infaunal holes were observed in the substrate.

Bottom Fauna

Brittle stars (Ophiuroidea) were the dominant member of the benthic community at this location with 30-50 individuals being present in a square metre. The community was basically epifaunal due to the compact nature of the sandy substrate. An outline of the fauna noted is presented in Table 2. The presence of woodwastes did not appear to be exerting a terribly significant impact on the benthic community as it appears as if the community was already epifaunal in nature. Faunal forms other than brittle stars were quite limited in number.

Neptunea sp. were noted in abundance on certain logs (16 on one log) and occasionally on the sandy substrate.

TABLE 2 FAUNAL LIST

Taxon	Abundance
Actinaria - *Metridium senile*	- noted occasionally
Pachycerianthus sp.	- noted occasionally
Unidentified - (orange with white spots)	- noted occasionally
Gastropoda - *Neptunea* sp.	- 16 observed on one log; Seen occasionally out on sand but mainly on logs
Crustacea - *Pandalopsis dispar*	- Second most abundant form found after Ophiuroidea

Taxon		Abundance
Crustacea (continued)		
	Unidentified pink shrimp	Most abundant form found after Ophiuroidea
	Unidentified Decorator Crab	1 noted
	Unidentified Hermit Crab	1 noted
Ophiuroidea		30-50 individuals per square metre
Pisces	*Hydrolagus colliei*	3 noted
	Gadus macrocephalus	1 noted
	Theragra chalcogramma	1 noted
	Ophion elongatus	1 noted
	Sebastolobus alascanus	1 noted
	Pleuronectidae	2 noted

Conclusions

The substrate at Track 4 was sandy in nature resulting in the fact that the community was basically epifaunal. Brittle stars (Ophiuroidea) were the dominant faunal form, with approximately 30-50 individuals being present in a square metre. Some woodwastes were noted indicating that dumping is occurring before the barges reach the designated dumpsite. The dissolved oxygen concentration, as measured by the CTD unit, was not depressed as a result of the presence of woodwastes. There appeared to be an impact on the bottom community at this site, however it was not as dramatic as at other dive sites around the dumpsite.

PISCES IV DIVE RECORD

Location: Point Grey Date: 29 November 1978

Dive No.: 717 (Track 5) (Fig. 49)

Observers: G. Packman, N. Holman

Position:	Start	Turn	Turn	Finish
	49°15.13'N	49°15.33'N	49°15.87'N	49°16.12'N
	123°19.18'W	123°19.38'W	123°19.06'W	123°19.27'W

Depth:

Water Column

The water column on descent was clear of detritus and zooplankton to a depth of approximately 80 metres. A zooplankton layer was present extending from 80m - 110m. The dominant zooplankters in this layer were pelagic amphipods and euphausids. At 110m the defined zooplankton layer cleared leaving the water fairly clear as little detritus was present. At 122 metres a siphonophore, decapod larvae and chaetognaths were noted. A siphonphore was also noted at 170 metres. At 160 metres the concentration of detritus increased and kept increasing until the bottom was reached, where the visibility was poor.

The water column characteristics as determined by the CTD are presented in Table 1. These data indicate that the dissolved oxygen near the bottom was not depleted.

TABLE 1 CTD OBSERVATIONS

Depth	Temperature (^{o}C)	Conductivity (m mhos/cm)	Dissolved Oxygen (mg/l)
0m	7.3	28.5	11.5
30m	9.5	32.4	8.6
65m	9.35	33.1	7.2
168m	8.48	32.8	8.1
190m	8.5	32.9	7.1
195m (bottom)	8.46	32.99	6.8
194m (bottom)	8.46	32.95	6.9
190m (bottom)	8.45	32.9	7.6
189m (bottom)	8.46	32.9	7.9
187m (bottom)	8.46	32.93	7.32
182m	8.0	32.9	6.6

Bottom Characteristics

At the beginning of the dive, the bottom consisted of a fairly clean soft sediment with a small amount of woodwaste and some hardpan mixed in. Occasional logs were also encountered. There were approximately 5-10 holes per square metre and some worm casting on the sediment. These conditions extended along the first leg of the dive.

At approximately the first bed in Track 5 the wood debris began to occur in small concentrations and steel bands from bundle booming were encountered. In one instance a considerable pile of steel bands was observed, indicating that the woody material in the nearby sediments had probably orginated from log pond dredging. At a point 0.4 km north of the dive site, the sediment became lighter in consistency and darker in colour, indicating a reducing type of sediment. The number of holes in the sediment was significantly reduced here and the bottom was noted as being quite degraded.

During the final stages of Track 5, the proportion of woody debris increased again. In this area a lot of shell debris was mixed in with dredged material with not much of a silt cover. Infaunal burrows here were virtually non-existent. Logs were also common in this area.

Bottom Fauna

Table 2 presents a list of the fauna observed during Track 5. At the beginning of the dive a fairly "normal" soft bottom community was observed. The dominant animals in this community include side-stripe shrimp (Pandalopsis dispar), unidentified pink shrimp and small shrimp which were either juvenile pinks or a small shrimp species. The large gastropod, Neptunea sp., was noted in abundance on sunken logs, presumably feeding on the white bacterial slime on these logs.

During the last 1/3 of the dive the number of infaunal holes decreased rapidly to the point where there were virtually none. This was observed to be concurrent with the increasing concentration of woodwastes in the sediments and their more reducing nature. Mixed in with these degraded sediments were a fair number of broken bivalve shells which may have been killed in situ but were more likely deposited with the dredged material. In general, faunal colonization in the area of these degraded sediments was decreased markedly.

Conclusions

During the last 1/3 of Track 5, in the area on a line between the North Arm of the Fraser and the dumpsite, the sediments were observed to be quite degraded, having a high concentration of woodwaste in them and having the appearance of reducing sediments.

The dissolved oxygen in the bottom water adjacent to these sediments was not depressed, however, according to the reading of the CTD unit. Biological activity was much reduced where the sediments were degraded, with infaunal burrows being almost non-existent.

TABLE 2 FAUNAL LIST

Taxon	Abundance
Nemertea	- fairly common
Actinaria - Pachycerianthus sp.	- fairly common
- Unidentified orange anemone with white spots on trunk	- fairly common

TABLE 2

FAUNAL LIST

Taxon		Abundance
Nemertea		- fairly common
Actinaria	- *Pachycerianthus* sp.	- fairly common
	- Unidentified orange anemone with white spots on trunk	- fairly common
Gastropoda	- *Neptunea* sp.	- on logs and in open - eggs on some logs
	- *Fusitriton* sp.	- 1 noted
Holothuroidea		
	- *Chirodota* sp.	- The present of Chirodota sp. was noted but abundance not obtained due to its infaunal nature
Asteroidea	- *Ctenodiscus* sp	- fairly common
	- *Mediaster* sp.	- 1 noted
Echinoidea		- 1 noted
Crustacea	- *Pandalopsis platyceros*	- 10 noted
	- *Pandalopsis dispar*	- common
	- Unidentified pink shrimp	- common
	- Unidentified juvenile shrimp (or smaller species)	- 1-2 individuals per square metre except in extremely degraded area
	- Unidentifed *Crangon* sp	- present but no indication of abundance
	- *Munida quadrispina*	- fairly common
	- *Pagurus* sp.	- fairly common
	- Tanner crab	- 8 noted

Taxon		Abundance
Pisces	- Squalus acanthias (juvenile)	- 9 noted
	- Squalus acanthias (adult)	- 1 noted
	- Hydrolagus colliei	- 4 noted
	- Microgadus proximus	- 3 noted
	- Stichaeidae	- 1 noted
	- Sebastes sp.	- 1 noted
	- Sebastolobus alascanus	- 14 noted
	Pleuronectidae	- 12 noted

PISCES IV DIVE RECORD

Location: Victoria (Quarantine Buoy
Pre 1977 Dumpsite) Date: 9 May 1979

Dive No.: 759 (Track 4) (Fig. 65)

Observers: G. Packman, B. Kay

Position:

Start	Turn	Turn	Finish
48°22.08'N	48°22.23'N	48°22.12'N	48°22.17'N
123°25.97'W	123°25.80'W	123°25.75'W	123°25.33'W

Depth: 80m

Water Column

Generally visibility was good throughout the descent through the water column. A fair bit of phytoplankton was apparent in the surface water. At 25 metres a lesser quantity of phytoplankton and some detritus was observed. At 50 metres more detritus and zooplankton including scyphozoans and some copepods were noted. The depth at the bottom was 80 metres and this remained constant throughout the dive.

Bottom Characteristics

Upon initial arrival at the bottom the substrate was observed to be sandier and siltier than the gravel substrate on the 1977 Quarantine Buoy dumpsite dive. Quite a few ridges were noted in the sand, presumably from the currents in the area. In this area the only evidence of dumped material was the occasional clump of hardpan clay.

As the dive progressed the substrate became more gravelly with broken shells mixed in. After a short period of time evidence of dumping activity became more apparent in the form of pieces of iron, wire cable, large rocks, bricks, construction rubble and pieces of machinery.

Bottom Fauna

A summary of the bottom fauna noted during the dive is contained in Table 1. The faunal forms noted were predominantly epifaunal due to the naturally coarse, compacted nature of the bottom. The community was well diversified but not exceptionally prolific.

Conclusions

Ocean dumping did not appear to have had a severe impact upon the benthic community in this area. The natural substrate consisted of gravel and sand such that the dumped material did not effect a gross change in that parameter. The finer fractions and woodwastes were not apparent in the disposal area, presumably having been carried away by strong currents. These fractions may turn up in unexpected areas of the shoreline. The benthic community was predominantly epifaunal in both affected and unaffected areas therefore it did not appear as though benthic productivity was being severly impacted although some impact is inevitable. The physical presence of the dumped construction material would impede commercial trawling in the area.

TABLE 1 FAUNA NOTED THROUGHOUT DIVE

Faunal Form	Abundance
Ptilosarcus gurneyi	1
Sea whip	1
Anemone unidentified	6
Nudibranch	1
Modiolus sp.	clumps noted throughout dive
Scallops	no scallops were noted initially but some where noted occasionally during the last 2/3 of the dive.
Parastichopus californicus	6
Asteroidea unidentified	2
Henricia sp.	3
Gorgonocephalus sp.	1
Ophiuroidea	1
Strongylocentrotus	5
Pagurus sp.	7

TABLE 1 (continued)

Faunal Form	Abundance
Spider Crab	2
Hydrolagus colliei	1
Gadus macrocephalus	2
Agonidae	6
Glyptocephalus zachirus	1
Pleuronectidae	4

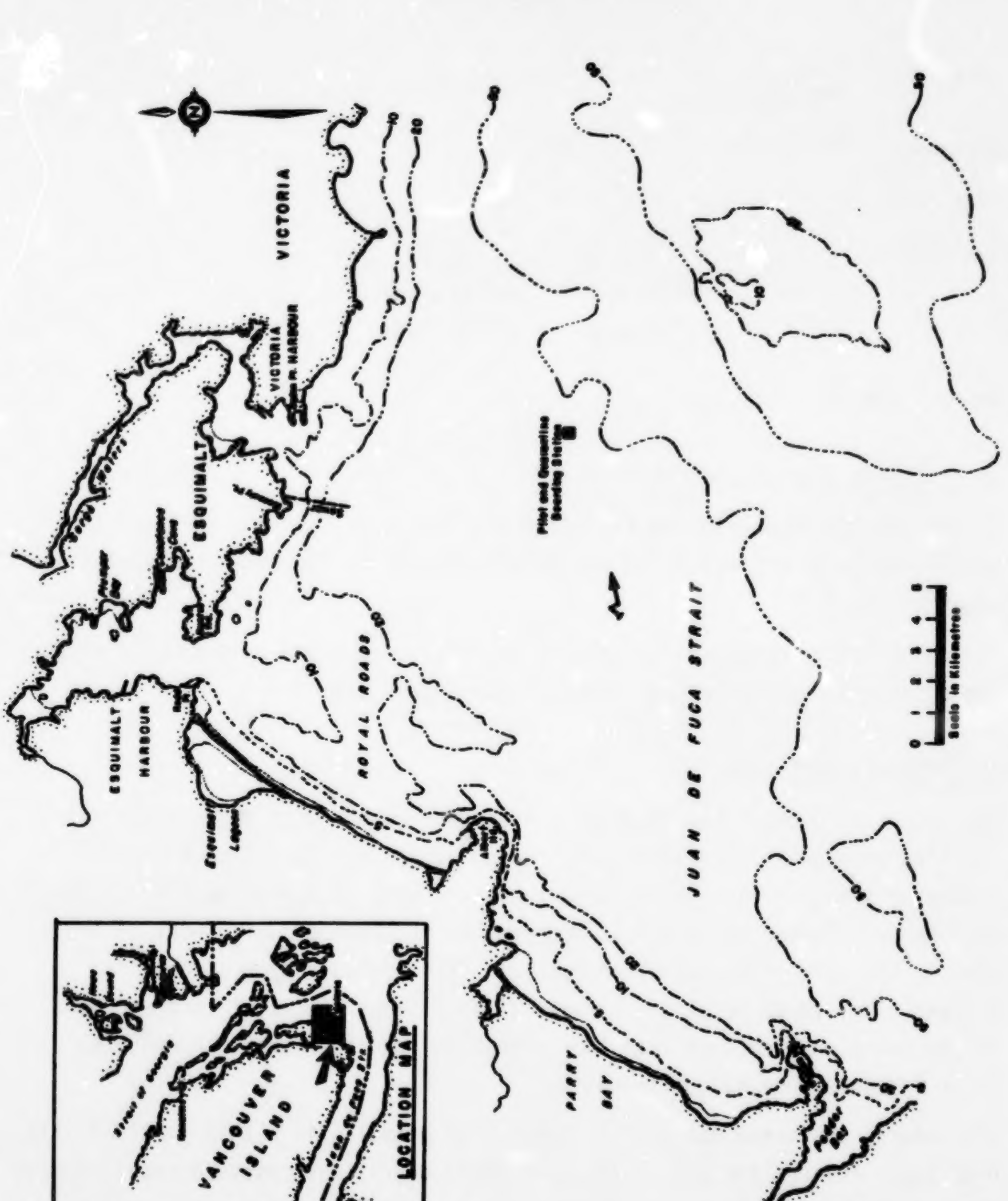
VICTORIA
VICTORIA HARBOUR
ESQUIMALT
ESQUIMALT HARBOUR
ROYAL ROADS
JUAN DE FUCA STRAIT
PARRY BAY
Pilot and Quarantine Boarding Station
Scale in Kilometres
0 1 2 3 4 5 6
10
20
30
VANCOUVER ISLAND
Strait of Georgia
LOCATION MAP

FIG. 65 PISCES DIVE TRACK, QUARANTINE BUOY (PRE 1977 DUMPSITE) 1979.

PISCES IV DIVE RECORD

Location: Victoria, (Quarantine Buoy 1977 Dumpsite)

Date: 9 May 1979

Dive No.: 758 (Track 3) (Fig. 66)

Observers: G. Packman, B. Kay

Position:	Start	Finish
	48°22.20'N	48°22.23'N
	123°23.68'W	123°23.20'W

Depth: 60m

Water Column Characteristics

Visibility throughout the water column was very good. On the surface a fair concentration of phytoplankton was apparent while at 27m some zooplankton began to appear.

At approximately 60 metres strings of detritus were noted in the water column. The occasional scyphozoan was noted in the deeper waters.

Bottom Characteristics

The bottom throughout the dive was gravelly in nature with the fine sediment fraction apparently scoured away by strong currents. The current was consistently strong during the dive having a velocity of approximately 1.0 km/hr. to 2 km/hr. Dumped material was apparent on the bottom during most of the dive in the form of construction rubble. This included broken concrete, hardpan clay, scrap metal and ceramic tiles. Somes pieces of concrete had yellow paint on them such that they resembled roadside curbs. A manhole cover and some rope were also noted.

The natural substrate appeared to consist of gravel with a thin layer of silt over top. Towards the end of the dive shell debris was observed mixed in with the gravel and fine silt. Occasionally patches of silt were noted. In the latter portion of the dive long undulating ridges, approximately 1.3 km in height were noted. It was difficult to assess the cause of these ridges, however scouring is a possibility.

Generally speaking it was difficult to pin point an effect of dumping on the bottom as bottom material appeared to be very naturally course.

Bottom Fauna

The bottom fauna observed during the course of this dive is presented in Table 1. The dominant faunal forms throughout most of the dive were scallops which were approximately 5 cm in diameter. These were observed in numbers of 5-10 individuals per square metre. Approximately 2/3 of the way through the dive a fairly dense concentration of starfish which were possibly *Orthasterias koehleri* was noted. This increased concentration of starfish extended for some distance over the bottom.

Generally speaking the bottom dwelling organisms were epifaunal in nature. There were virtually no holes, from infaunal organisms, in the substrate. Therefore the dumping of construction type material should not have a great impact upon the benthic community as a whole and this in fact, appeared to be the case.

TABLE 1

Faunal Forms	Abundance
Porifera	- noted occasionally
Anemone-unidentified	- 1
Serpulidae	- noted occasionally on rocks
Scallops	- dominant faunal form throughout the dive - numbers varied but ranged up to approx. 5-10/m^2
Modiolus sp.	- found in clumps in soft substrate areas
Fusitriton sp.	- 1
Parastichopus californicus	- 2
Psolus chitinoides	- 2
Cucumaria sp. (?)	- 4
Echinoidea	- noted occasionally throughout dive
Solaster stimpsoni	- 3
Henricia	- 5

TABLE 1 (continued)

Faunal Forms	Abundance
Mediaster sp.	- 1
Pycnopodia sp.	- 1
Orthasterias koehleri	- dominant faunal form in the area 2/3 of the way through the dive
Asteroidea (unidentified)	- 1
Gorgonocephalus sp.	- 7
Pagurus sp.	- 1
Hydrolagus colliei	- 5
Microgadus proximus	- 1
Ophiodon elongatus	- 1
Glyptocephalus zachirus	- 1
Pleuronectidae	- 2

Conclusions

Dumped material was apparent on the bottom throughout most of the dive. The natural substrate was mainly gravel with a thin layer of sediment over it. Generally speaking the bottom fauna was predominantly epi-faunal with scallops being the dominant form. Ocean dumping did not appear to have had a drastic impact upon the substrate or bottom community as the bottom was already composed of gravel and the community epifaunal.

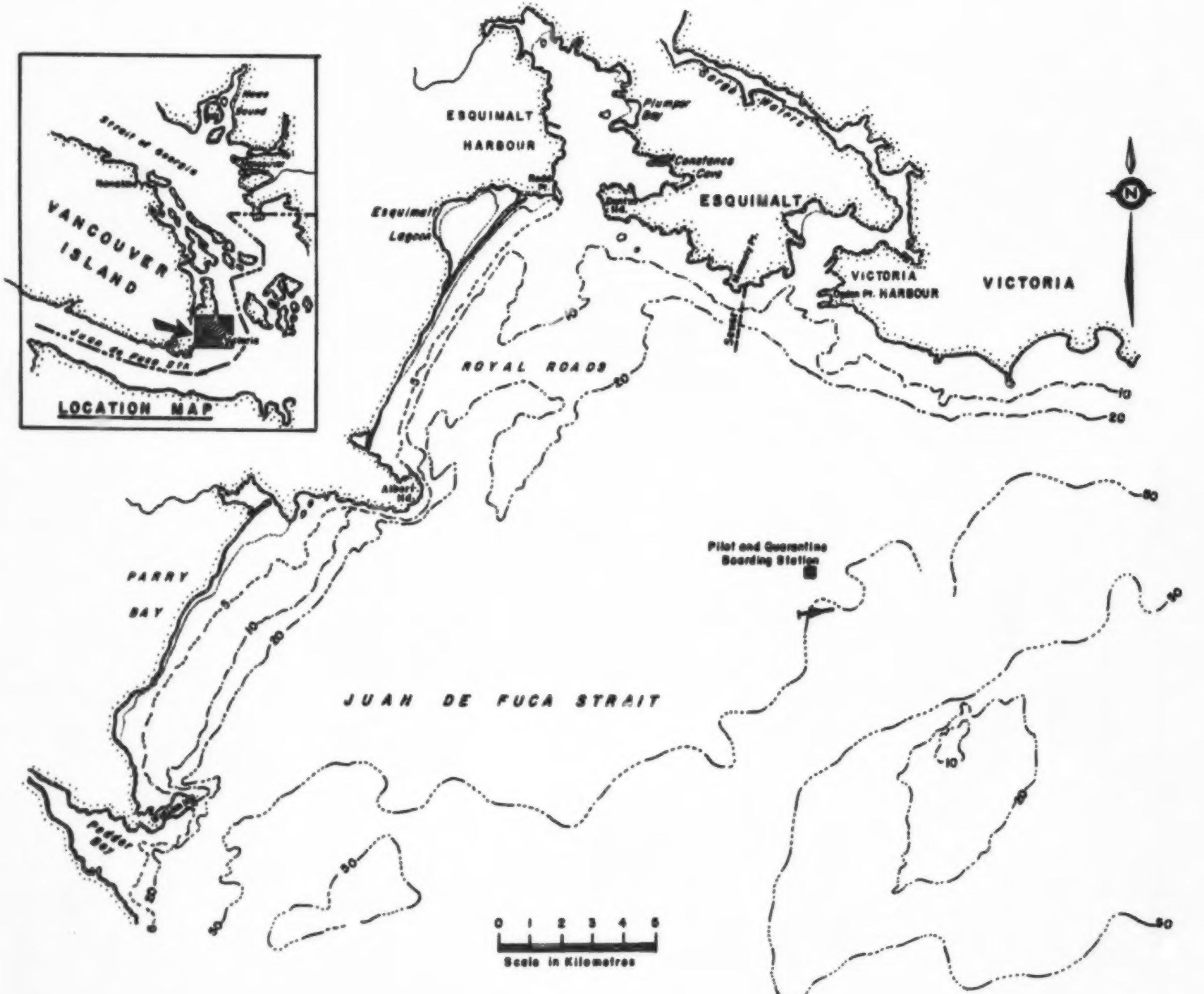
LOCATION MAP
VANCOUVER ISLAND
Strait of Georgia
Howe Sound
Juan de Fuca Str.
ESQUIMALT HARBOUR
Esquimalt Lagoon
Plumper Bay
Constance Cove
ESQUIMALT
Gorge Waters
VICTORIA HARBOUR
VICTORIA
ROYAL ROADS
Albert Hd.
PARRY BAY
Pedder Bay
JUAN DE FUCA STRAIT
Pilot and Quarantine Boarding Station
N
10
20
50
0 1 2 3 4 5
Scale in Kilometres

FIG. 66 PISCES DIVE TRACK, VICTORIA (QUARANTINE BUOY 1977 DUMPSITE) 1979.

PISCES IV DIVE RECORD

Location: Off Quarantine Buoy dumpsite Date: 8 May 1979

Dive No.: (Fig. 67)

Observer: D. Goyette

Position:

	Start	Finish
	48°22.13'N	48°22.03'N
	123°22.93'W	123°22.72'W

Depth:

Note: No dive report available.
No photographs.

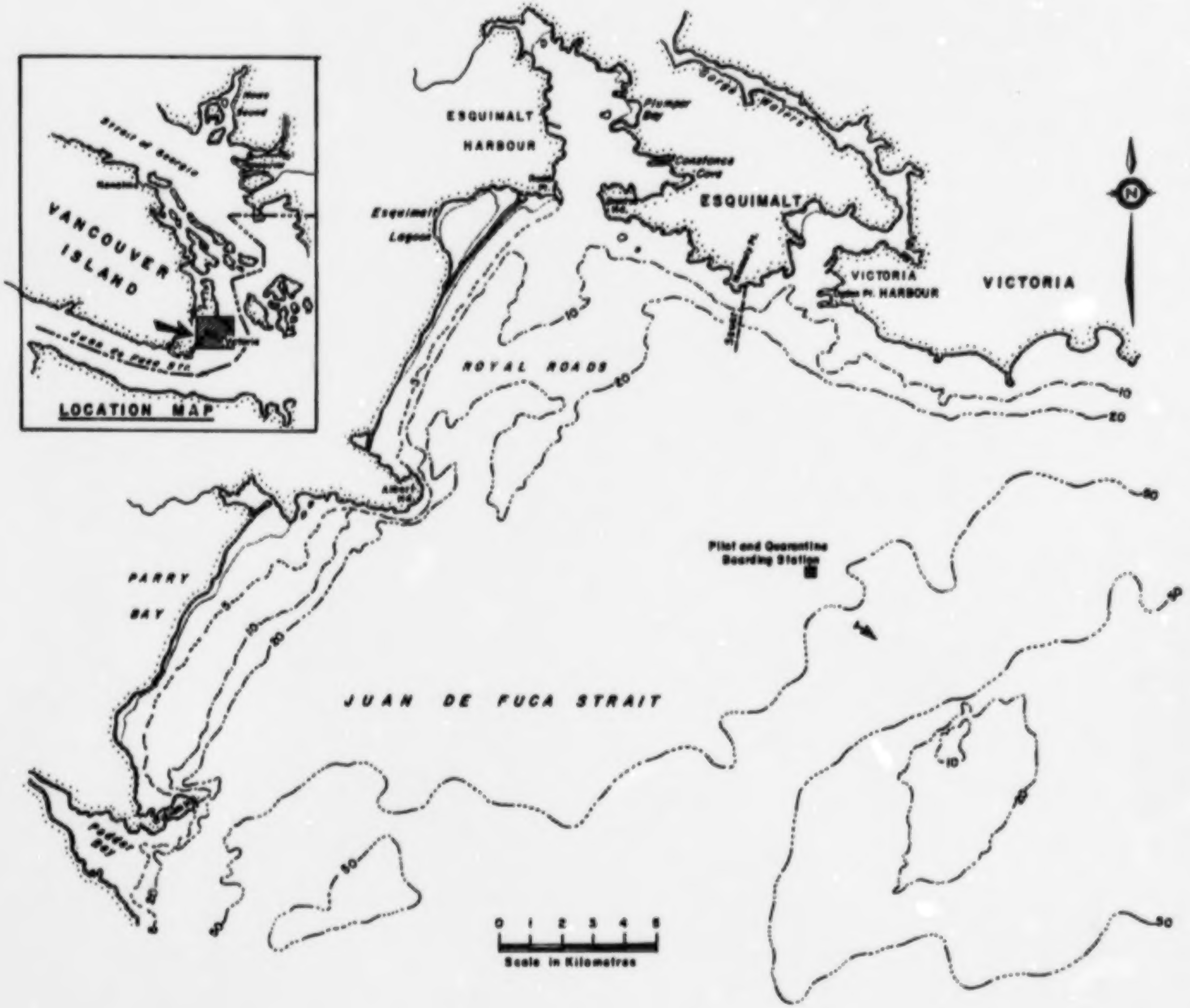
LOCATION MAP
VANCOUVER ISLAND
Strait of Georgia
Juan de Fuca Str.
ESQUIMALT HARBOUR
Esquimalt Lagoon
Plumper Bay
Constance Cove
ESQUIMALT
Gorge Waters
VICTORIA HARBOUR
VICTORIA
ROYAL ROADS
PARRY BAY
Pedder Bay
JUAN DE FUCA STRAIT
Pilot and Quarantine Boarding Station
N
0 1 2 3 4 5
Scale in Kilometres
10
20
30
50

FIG. 67 PISCES DIVE TRACK, VICTORIA (OFF QUARANTINE BUOY DUMPSITE) 1979.

PISCES IV DIVE RECORD

Location: (Victoria) Quarantine Buoy (1978 dumpsite)

Date: 8 May 1979

Dive No.: (Fig. 68)

Observers: D. Goyette, N. Holman

Position:	Start	Turn	Finish
	48°22.50'N	48°22.70'N	48°22.60'N
	123°22.08'W	123°21.90'W	123°21.59'W

Depth:

Note: No dive report available.

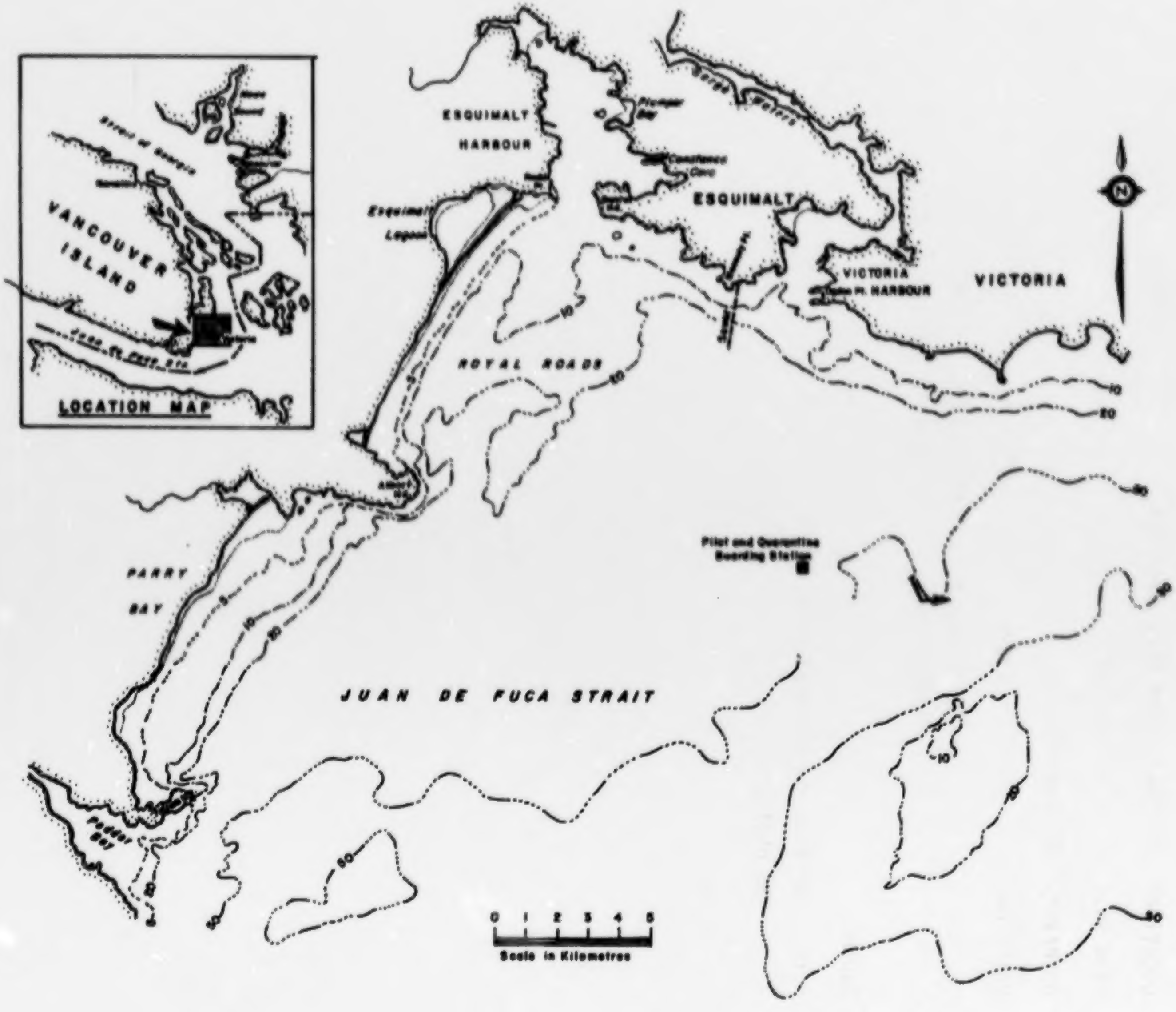
Strait of Georgia
VANCOUVER ISLAND
Juan de Fuca Str.
LOCATION MAP
ESQUIMALT HARBOUR
Plumper Bay
Constance Cove
Gorge Waters
ESQUIMALT
VICTORIA HARBOUR
VICTORIA
Esquimalt Lagoon
ROYAL ROADS
PARRY BAY
Pedder Bay
JUAN DE FUCA STRAIT
Pilot and Quarantine Boarding Station
N
10
20
50
0 1 2 3 4 5
Scale in Kilometres

FIG. 68 PISCES DIVE TRACK, QUARANTINE BUOY (1978 DUMPSITE) 1979.

PISCES IV DIVE RECORD

Location: off Quarantine Buoy dumpsite Date: 9 May 1979

Dive No.: (Fig. 69)

Observer: D. Goyette

Position:

Start	Turn	Finish
48°22.40'N	48°22.43'N	48°22.65'N
123°21.00'W	123°20.44'W	123°19.88'W

Depth:

Note: No dive report available.
No photographs.

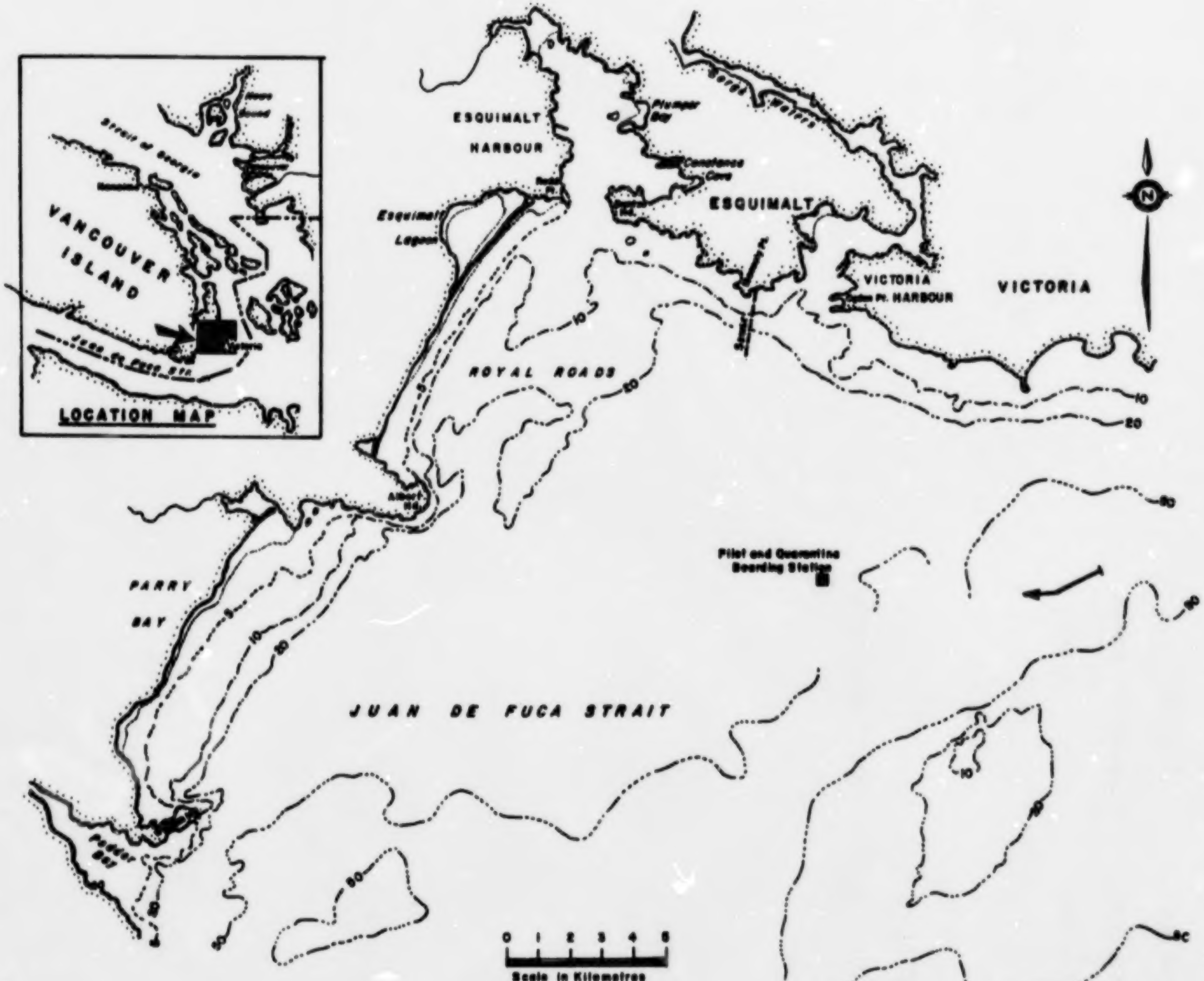
LOCATION MAP
VANCOUVER ISLAND
Strait of Georgia
Juan de Fuca Str.
ESQUIMALT HARBOUR
Esquimalt Lagoon
Plumper Bay
Constance Cove
ESQUIMALT
Gorge Waters
VICTORIA HARBOUR
VICTORIA
ROYAL ROADS
Albert Hd.
PARRY BAY
Pedder Bay
JUAN DE FUCA STRAIT
Pilot and Quarantine Boarding Station
10
20
50
0 1 2 3 4 5
Scale in Kilometres

FIG. 69 PISCES DIVE TRACK, VICTORIA (OFF QUARANTINE BUOY DUMPSITE) 1979.

PISCES IV DIVE RECORD

Location: Constance Bank (off Victoria) Date: 9 May 1979

Dive No.: (Fig. 70)

Observers: D. Goyette, N. Homan

Position:	Start	Turn	Turn	Finish
	48°19.75'N	48°19.77'N	48°20.24'N	48°28.30'N
	123°21.52'W	123°20.57'W	123°20.01'W	123°19.68'W

Depth:

Note: No dive report available.

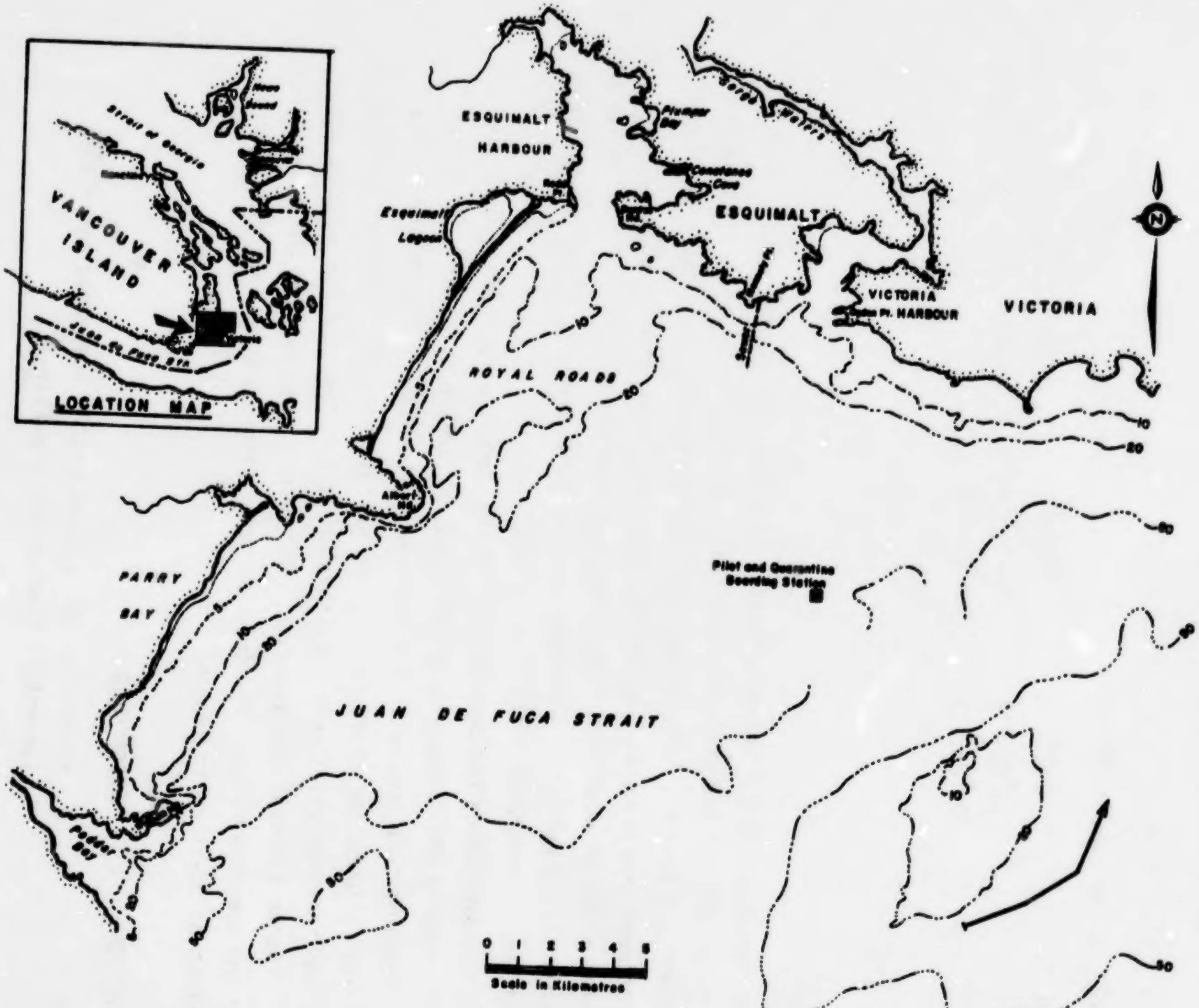
LOCATION MAP
VANCOUVER ISLAND
Strait of Georgia
Juan de Fuca Str.
ESQUIMALT HARBOUR
Esquimalt Lagoon
Plumper Bay
Constance Cove
Gorge Waters
ESQUIMALT
VICTORIA HARBOUR
VICTORIA
ROYAL ROADS
Albert Head
PARRY BAY
Pedder Bay
JUAN DE FUCA STRAIT
Pilot and Quarantine Boarding Station
10
20
50
0 1 2 3 4 5
Scale in Kilometres

FIG. 70 PISCES DIVE TRACK, VICTORIA (CONSTANCE BANK) 1979.

PISCES IV DIVE RECORD

Location:	Malaspina Strait (proposed Ocean Dump Site East of Grief Pt.)	Date:	10 March 1980

Dive No.: 826 (Fig. 71)

Observers: H. Nelson, D. Brothers

Position:	Start	Finish
	49°45.3'N	49°44.6'N
	124°28.0'W	124°27.3'W

Depth: 322m

SUMMARY:

The dive commenced in 322 metres of water at a position approximately 1000 metres north-west of the proposed dump site. Visibility on the bottom was approximately 6 metres. Bottom substrate consisted of a thin layer of light-brown sediment overlying soft clay-like material light grey in colour. The occasional piece of wood debris observed had trenches at the base indicative of relatively strong current. There was considerable evidence of burrowing (some of which was in progress). The submersible moved off at a course of 120° towards a "pinger" which had been placed at the dumpsite location. The submersible reached the "pinger" and continued on for approximately 200 metres before changing to a course of 200° and heading towards Texada Island. This course was followed for approximately 500 metres where the dive was terminated. The bottom remained relatively flat throughout the dive and the benthos was fairly diverse although not abundant. Dominant organisms were the side stripe shrimp and the Dover sole. The only uncommon life observed were two brown cat-sharks at 30-60 cm in length.

OBSERVATIONS:	Descending
0- 70m	- visibility good, considerable suspended material (detritus) however few plankters.
70-200m	- siphonophores and pelagic amphipods. Many euphausiids at 100m
200-300m	- one hake (*Merluccius productus*), one spiny dogfish (*Squalus acanthias*)

322m

Bottom

- Fishes observed included several Hake, ratfish (*Hydrolagus colliei*), Pacific cod (*Gadus macrocephalus*), Dover sole (*Microstoma pacificus*), brown cat sharks (*Apristurus brunneus*) poachers and eel pouts.
- other organisms observed on the bottom included: squat lobsters, burrowing anemones, octopus (single), nemerteans, sea pens (small), pelagic polychaetes, mud stars, Tanner crabs, heart urchins, whelks, and large anemones.

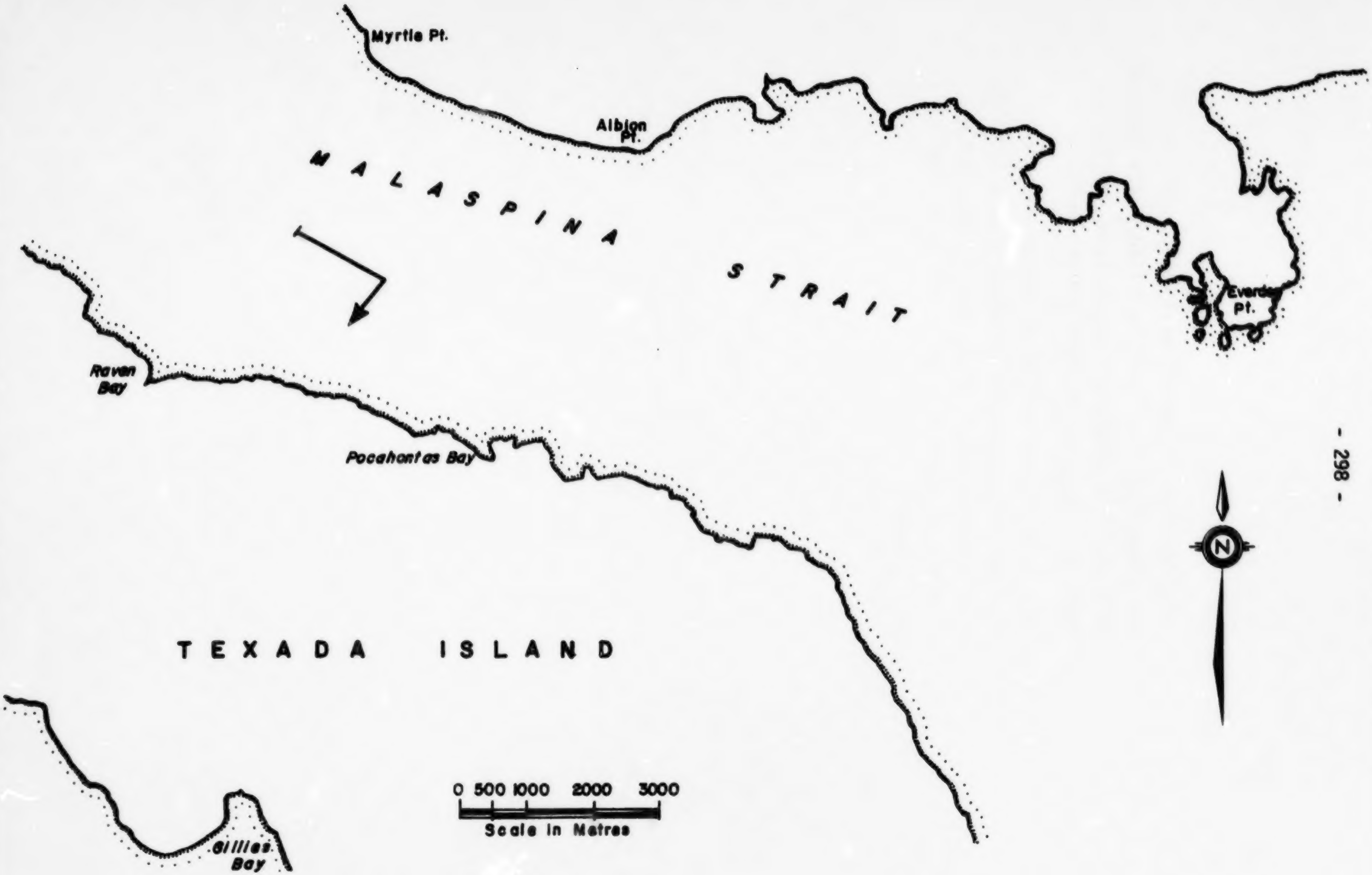
Myrtle Pt.
Albion Pt.
MALASPINA STRAIT
Pt.
Raven Bay
Pocahontas Bay
TEXADA ISLAND
0 500 1000 2000 3000
Scale in Metres
Gillies Bay
N

FIG. 71 PISCES DIVE TRACK, MALASPINA STRAIT (1980). PROPOSED DUMPSITE

PISCES IV DIVE RECORD

Location: 10 km West of Kelsey Bay (Johnstone Strait south) Date: 12 March 1980

Dive No.: 828 (Track 3) (Fig. 72)

Observers: H. Nelson, D. Brothers

Position:	Start	Finish
	50°27.8'N	50°27.3'N
	126°04.7'W	126°05.0'W

Depth: 290m

SUMMARY:

The dive commenced in 290 metres of water. Bottom substrate was soft sediment approximately 10 cm thick interspersed with rocks and gravel. Visibility on the bottom was approximately 6 metres. The bottom was occupied by a diverse community with the most notable members being several species of starfish and many ophiuroids on the soft substrate and numerous anemones, corals, and sponges on the rocks. The PISCES headed on a course of 270° - 280° against a current of approximately 1 km/hr. This track was followed for 800 metres without appreciable change in depth, substrate or biota. The exact ocean dump site was estimated to be approximately 300 metres along this track. After 800 metres the PISCES turned to Port (heading south-east) for approximately 500 metres and then turned towards Texada Island for another 500 metres. During the shoreward run more rock and gravel were encountered and a considerable amount of wood debris scattered over the bottom. The Dive was terminated at 270 metres depth approximately 300 metres from shore.

OBSERVATIONS:

Descending

0 - 70m	- fine detritus in water column with very few plankters.
70 - 290m	- a few pelagic amphipods, a single euphausid, plankton very scarce.

Bottom

- fishes observed during the Dive included ratfish

(Hydrolagus colliei), dog fish (Squalus acanthius), pollock (Theragra chalcogramma), skate (Raja sp.), lemon sole (Parophrys vetulus), Dover sole (Microstoma pacificus), lumpfish (Cydopteridae).

- other biota included brittle stars, hermit crabs (Pagurus sp.), sidestripe shrimp (Pandalopsis dispar), brachiopods, urchins, scallops, sponges, nudibranchs, crinoids, corals, nemerteans, anemones, and juvenile crabs (possibly box crabs).

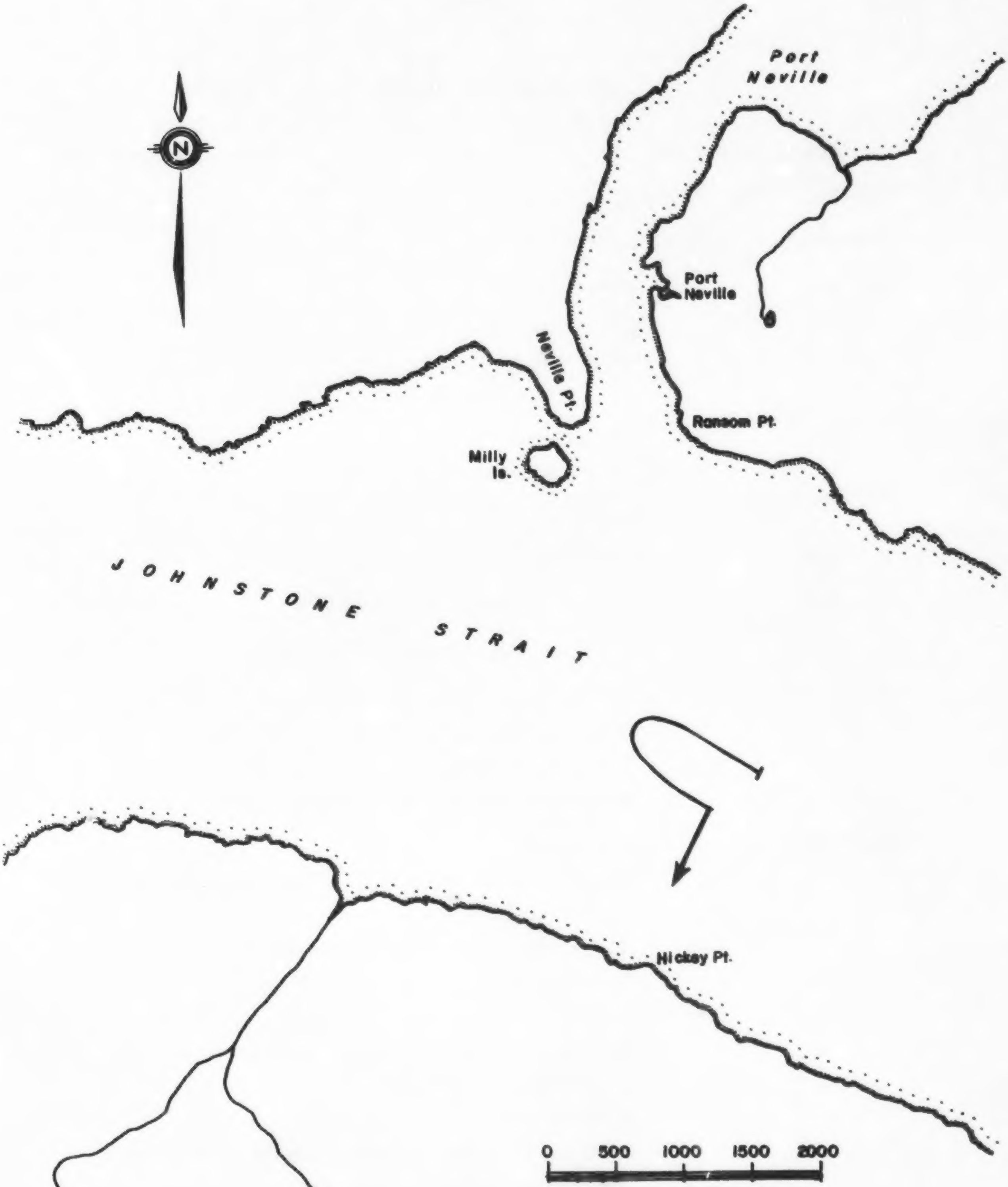
Port Neville
N
Port Neville
Neville Pt.
Ransom Pt.
Milly Is.
JOHNSTONE STRAIT
Hickey Pt.
0 500 1000 1500 2000
Scale in Metres

FIG. 72 PISCES DIVE TRACK, JOHNSTONE STRAIT (1980).
PROPOSED DUMPSITE

PISCES IV DIVE RECORD

Location: Kelsey Bay Date: 12 March 1980

Dive No.: 829 (Fig. 73)

Observers: H. Nelson, D. Brothers

Position:

50°26.10'N	50°26.50'N
126°00.50'W	126°00.40'W

Depth: 250m

Water Column

0 - 40m	- very clear, no plankton
40 - 100m	- fine detritus, a few plankters
100 - 175m	- more detritus, larger particles
bottom 200m	- sandy, good visibility ca. 8m
	- many scallop shells
	- sand with ripples
	- sand ridge then gravel, shells, rocks
travel 600m	- sand mounds
	- picket of wood fragments on down current side heading on course 210°
	- barren compared to previous dive
	- 2 or 3 dogfish
	- colonial bryophytes
	- most numerous animal is sea urchin S. paladus, S. purpatus
	- hermit crabs
	- rocks quite clean, probably due to sand action
	- nemerteans, ratfish, large barnacles, basket star, pink corals, very few small fish, anemone, starfish (3 species)

- absence of sponges
- 3 or 4 flatfish
- skates (juvenile)
- spider crab
- much evidence of strong currents

SUMMARY

Everything from large boulders with pink coral in short stalked clumps to fine beach sand and gravel with pockets of wood fragments.

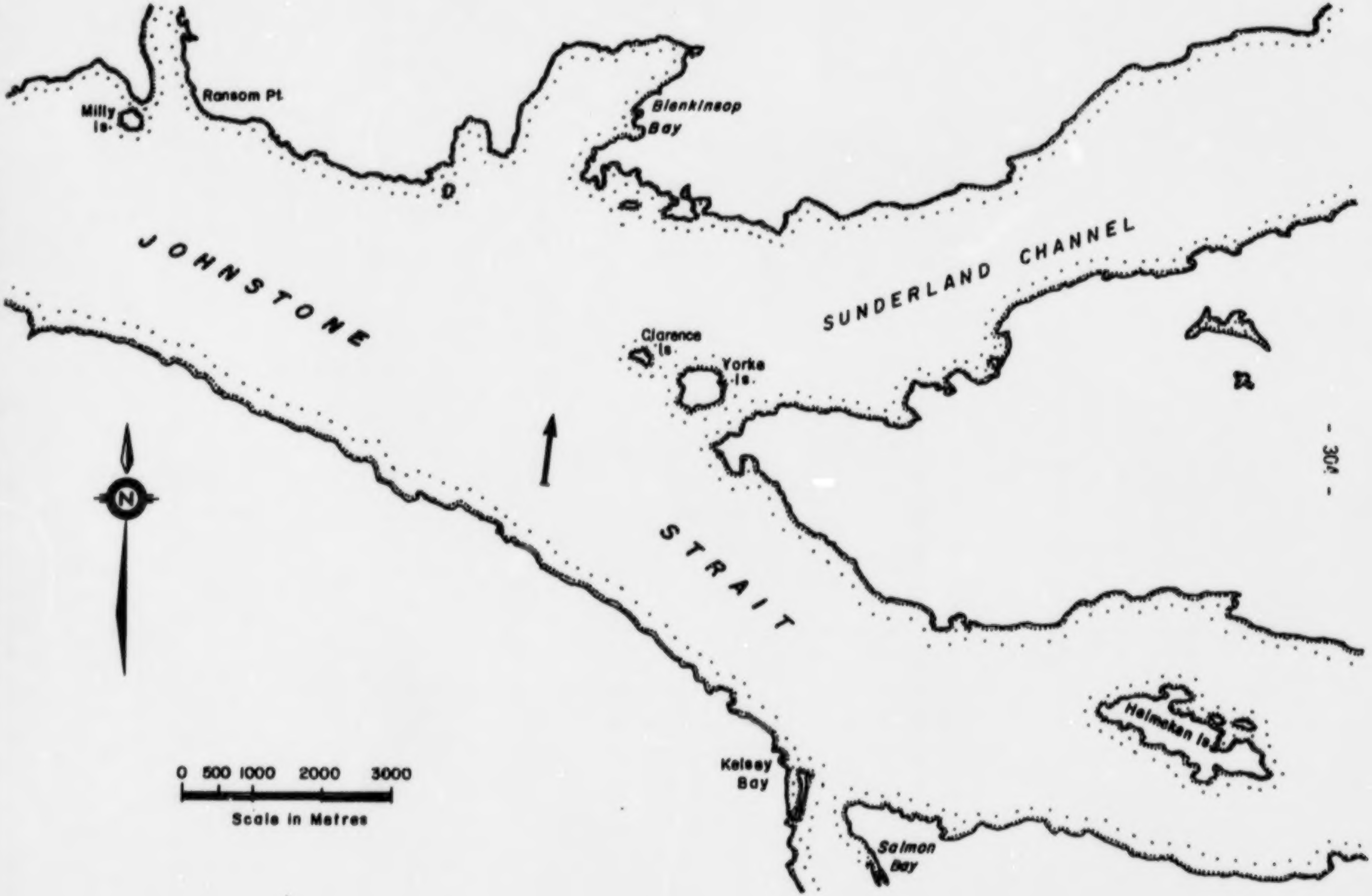
Milly Is.
Ransom Pt.
Blenkinsop Bay
D
JOHNSTONE
SUNDERLAND CHANNEL
Clarence Is.
Yorke Is.
N
STRAIT
Kelsey Bay
Helmcken Is.
Salmon Bay
0 500 1000 2000 3000
Scale in Metres

FIG. 73 PROPOSED OCEAN DUMPSITE NEAR KELSEY BAY (1980).

PISCES IV DIVE RECORD

Location: Ocean Dump Site off Porlier Pass
Date: 14 March 1980

Dive No.: 831 (Track 5) (Fig. 74)

Observers: H. Nelson, R. Kussat

Position:

	Start	Finish
	49°00.2'N	49°00.8'N
	123°29.8'W	123°29.8'W

Depth: 208m

SUMMARY

The bottom substrate was a thin layer of soft light brown sediment overlying greyish fine sediment. It did not appear to be a reducing sediment. In several locations large pieces of clay were observed over the natural sediment indicative of dumping activity. Large pieces of wood debris and logs were also observed as were metal bands used to bundle logs. There was a current of approximately 1 km/hr from 150°. Evidence of burrowing activity was considerable and the dominant organism seemed to be sidestripe shrimp; many pelagic shrimp were swimming just off the bottom. Although ocean disposal of forest product wastes had occurred in the area no deleterious effects were noted. Several species of fish were noted however they were not abundant. The bottom remained relatively flat throughout the dive.

OBSERVATIONS:

Descending

0 - 30m - visibility good, little detritus, no plankters.

30 - 70m - few arrow worms and siphonophores.

100m - few euphasids.

130m - pelagic amphipods, pelagic shrimp.

175 - 195m - several plankters observed and small fish believed to be northern smooth tongue.

Bottom

208 m - fishes observed during the dive included skate (Raja sp.), dog fish (Squalus acanthius), brown cat shark (Apristurus brunneus), rat fish (Hydrolagus colliei), flatfish (species unknown), rockfish (species unknown).

- commercial species of shrimp included the sidestripe (Pandalopsis dispar) which was very abundant.

- other benthic organisms included; 2 small octopus, pelagic shrimp, nemerteans, burrowing anemone, large anemone, tanner crabs.

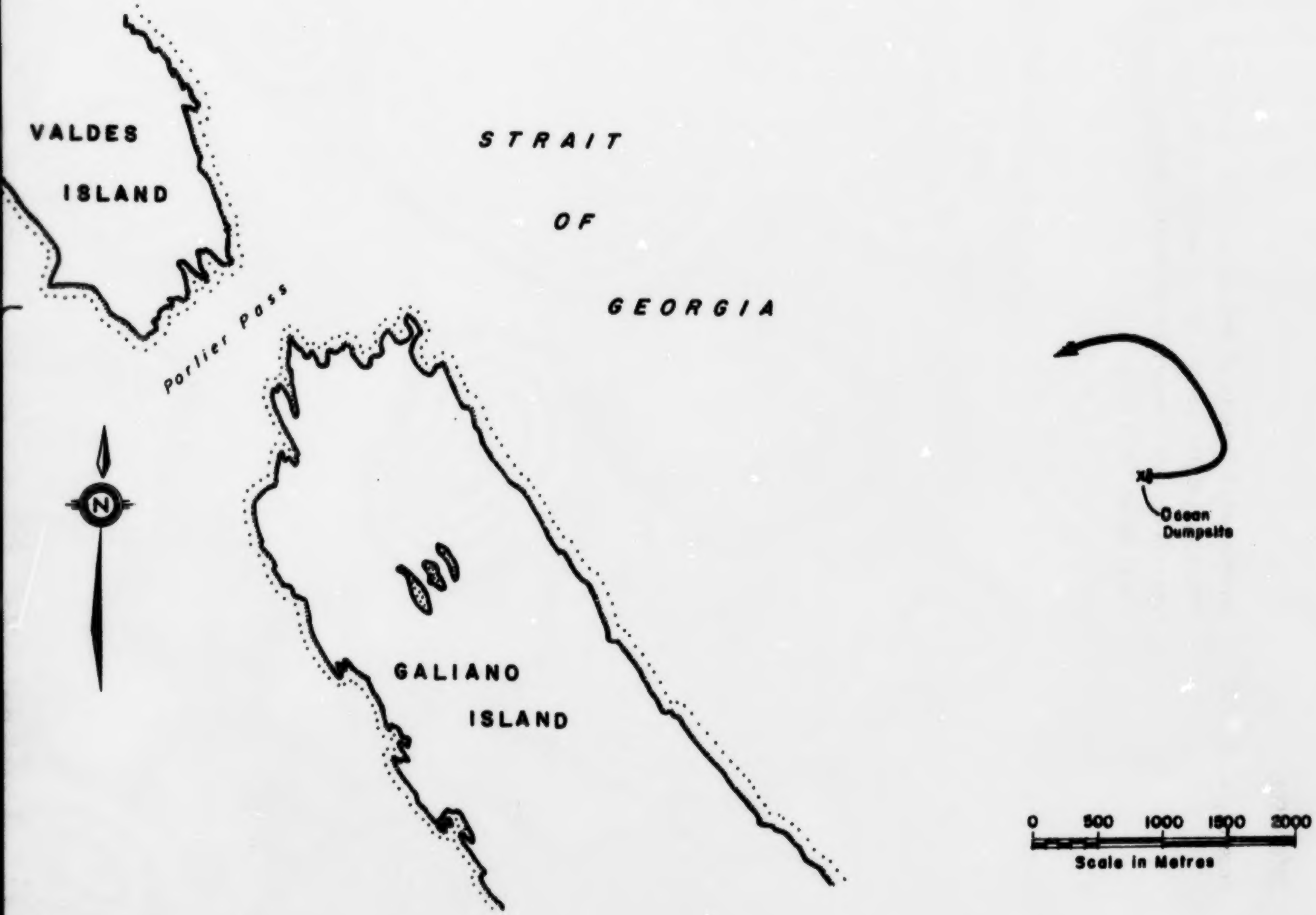
VALDES
ISLAND
STRAIT
OF
GEORGIA
Porlier Pass
N
Ocean
Dumpsite
GALIANO
ISLAND
0
500
1000
1500
2000
Scale in Metres

FIG. 74 PISCES DIVE TRACK, OCEAN DUMPSITE OFF PORLIER PASS (1980).

References

Pomeroy, W. M. 1982 Environmental Impacts of Bottom Deposits Originating From B.C. Coastal Pulpmills: A General Summary. Prepared for 49th Annual PNPCA Meeting and 1982 Annual BCWWA Conference.

Appendix I

Reference table of PISCES IV
Dives 1973 - 1982

DIVE NO.	LOCATION	DATE	INDUSTRIAL SECTOR INVOLVED	FIGURE NO.	REPORT AVAILABLE	16 mm FILM (approximate length) (minutes)	PHOTOGRAPHS
	Howe Sound	1973	control				
294	Holberg Inlet	11 February 1975	mine (control dive)	37	EPS 5-PR-77-11		
296	Rupert Inlet	11 February 1975	mine (Island Copper)	37	EPS 5-PR-77-11		
297	Rupert Inlet	12 February 1975	mine (Island Copper)	37	EPS 5-PR-77-11		
298	Holberg Inlet	13 February 1975	mine (control dive)	37	EPS 5-PR-77-11		
299	Holberg Inlet (head)	13 February 1975	control	37	EPS 5-PR-77-11		
300	Quatsino Sound	14 February 1975	mine (Island Copper)	37	EPS 5-PR-77-11		
460	Howe Sound	23 August 1976	mine (control)	38			
461	Howe Sound	23 August 1976	mine (Anaconda) pulpmill (Woodfibre)	38			
462 (track 2)	Howe Sound (Britannia)	24 August 1976	mine (Anaconda) pulpmill (Woodfibre)	38			
462 (track 3)	Howe Sound (North of Britannia)	24 August 1976	mine (Anaconda) pulpmill (Woodfibre)	38			
463 (track 2)	Howe Sound (North of Watts Point)	25 August 1976	pulpmill (Woodfibre)	38			
464	Howe Sound (Thornbrough Channel)	26 August 1976	mine (Anaconda) pulpmill (Port Mellon)	38	79-2		
465	Howe Sound (Thornbrough Channel off Hillside Gravel Pit)	26 August 1976	pulpmill (Port Mellon) gravel pit (Hillside)	38	79-2		
466	Howe Sound (Thornbrough Channel, east of Woodridge Is.)	27 August 1976	pulpmill (Port Mellon) gravel pit (Hillside)	38	79-2		
467	Howe Sound (Thornbrough Channel off Mannion Creek)	27 August 1976	control	38			
468	Bute Inlet (Littleton Point)	28 August 1976	control	39			
469	Bute Inlet (Mouth)	28 August 1976	control	39			
473 (track 2)	Strait of Georgia (off Texada Mine)	31 August 1976	mine (Texada)	40	no	04	

Continued...

DIVE NO.	LOCATION	DATE	INDUSTRIAL SECTOR INVOLVED	FIGURE NO.	REPORT AVAILABLE	16 mm FILM (approximate length) (minutes)	PHOTOGRAPHS
514 (track 1) 515 (track 2)	Kitimat Arm (head)	21 October 1976	smelter (Kitimat)	41	EPS 5-PR-77-7	17	yes
518 519	Hastings Arm	23 October 1976	control	42	79-17		
520	Alice Arm (head)	24 October 1976	mine (AMAX/Kitsault)	42	79-17		
521	Alice Arm (centre)	24 October 1976	mine (AMAX/Kitsault)	42	79-17		
522	Alice Arm (mouth)	25 October 1976	mine (AMAX/Kitsault)	42	79-17		
523	Observatory Inlet	25 October 1976	mine (control)	42	79-17		
653 (tracks 1 & 2)	Howe Sound (near Britannia Beach)	20 April 1978	mine (Anaconda)	43	no	06	
654	Howe Sound (off Porteau Cove)	21 April 1978	mine (Anaconda)	44	no	06	
655	Howe Sound	21 April 1978	mine (Anaconda)	45	no	05	
656 (tracks 1 & 2)	Howe Sound	22 April 1978	mine (Anaconda)	46	no		
1102 1103	Alice Arm (near Pearson Point)	8 July 1982	mine (AMAX/Kitsault)	47	83-05		
1104	Alice Arm	9 July 1982	mine (AMAX/Kitsault)	47	83-05		
1105	Alice Arm (off Pearson Point)	9 July 1982	mine (AMAX/Kitsault)	47	83-05		
1106	Alice Arm (off Hans Point)	10 July 1982	mine (AMAX/Kitsault)	47	83-05		
1107	Alice Arm	10 July 1982	mine (AMAX/Kitsault)	47	83-05		
1108	Alice Arm (across from Hans Pt.)	11 July 1982	mine (AMAX/Kitsault)	47	83-05		
1109	Alice Arm	11 July 1982	mine (AMAX/Kitsault)	47	83-05		
1110	Hastings Arm (Granby Bay)	12 July 1982	control	47	83-05		
1111	Alice Arm	13 July 1982	mine (AMAX/Kitsault)	47	83-05		
1112	Hastings Arm (off Carr Point)	13 July 1982	control	47	83-05		
463 (track 1)	Howe Sound (Watts Point)	25 August 1976	pulpmill (Woodfibre)	14			
476	Northumberland Channel (off Harmac)	1 September 1976	pulpmill (Harmac)	15	79-8	08	

DIVE NO.	LOCATION	DATE	INDUSTRIAL SECTOR INVOLVED	FIGURE NO.	REPORT AVAILABLE	16 mm FILM (approximate length) (minutes)	PHOTOGRAPHS
512 513	Cousins Inlet (Ocean Falls)	20 October 1976	pulpmill (Ocean Falls) suitable for ocean dumpsite	16,17	79-6	22	yes
516 517	Prince Rupert (Chatham Sound)	22 October 1976	pulpmill (Prince Rupert ocean dumpsite	18,19		04	
591	Satellite Channel (Cape Keppel)	8 March 1977	pulpmill (Chemainus) ocean dumpsite	20		04	yes
593	Alberni Inlet (south of ten mile point)	11 March 1977	pulpmill (Port Alberni)	21	79-11	03	yes
594	Alberni Inlet (Stamp Narrows)	11 March 1977	pulpmill (Port Alberni) ocean dumpsite (Stamp Narrows)	56	79-11	06	yes
595	Muchalat Inlet (off Gold River)	12 March 1977	pulpmill (Tahsis/Gold River) ocean dumping	22	79-10	07	
597 (track 14)	Tahsis Inlet (Mozino Point)	13 March 1977	pulpmill (Tahsis/Gold River) old ocean dumpsite	23		06	yes
598 (track 15)	Tahsis Inlet	13 March 1977	pulpmill (Tahsis/Gold River) old ocean dumpsite	24		06	
647 (tracks 1 & 2)	Stuart Channel (off Crofton pulpmill)	12 April 1978	pulpmill (Crofton)	25	79-5	11	
649 (track 1)	Northumberland Channel (off Harmac diffuser)	14 April 1978	pulpmill (Harmac)	26	79-8	13	
651 (track 2)	Northumberland Channel (off Harmac diffuser)	15 April 1978	pulpmill (Harmac)	27	79-8	13	
719	Malaspina Strait (Powell River)	30 November 1978	pulpmill (proposed diffuser location Powell River)	28	79-14	08	
761 762	Northumberland Channel (Harmac)	10 May 1979	pulpmill (Harmac diffuser)	29		16	
764 (tracks 1 & 2)	Woodfibre	11 May 1979	pulpmill (Woodfibre)	30		11	
827	Powell River	11 March 1980	pulpmill (Powell River)	31		03	
834	Northumberland Channel (Harmac)	18 March 1980	pulpmill (Harmac)	32	no	05	
835	Stuart Channel (off Crofton)	19 March 1980	pulpmill (Crofton)	33	no	06	
1012 (tracks 1 & 2)	Thornbrough Channel (off Port Mellon)	19 March 1981	pulpmill (proposed diffuser location off Port Mellon)	34			

Continued...

DIVE NO.	LOCATION	DATE	INDUSTRIAL SECTOR INVOLVED	FIGURE NO.	REPORT AVAILABLE	16 mm FILM (approximate length) (minutes)	PHOTOGRAPHS
991 (track 2)	Northumberland Channel (Harmac)	25 & 26 February 1981	pulpmill (Harmac)	35	no	15	
992 (track 1)							
993 (track 3)							
382 (tracks 2 & 3)	Five Finger Island	January 1976	municipal discharge (Nanaimo)	2	EPS 5-PR-77-3	30	yes
472	Cape Lazo	31 August 1976	municipal discharge (Comox)	3	no	05	
474	Strait of Georgia (off Five Finger Island)	1 September 1976	municipal discharge	4	EPS 5-PR-77-3	04	
648	Five Finger Island	13 April 1978	municipal discharge (Nanaimo)	5	81-4	13	
662	French Creek	16 April 1978	municipal discharge (Qualicum/ Parksville)	6	82-12	10	
719 (tracks 1 & 2)	Comox (Cape Lazo)	1 December 1978	municipal discharge (Cape Lazo)	7	81-1	14	
756	Victoria (Macaulay Point)	7 May 1979	municipal discharge	8		11	
763	Sechelt (Trail Bay)	10 May 1979	municipal discharge	9		13	
765	Sechelt (Trail Bay)	12 May 1979	municipal discharge	9		13	
832	French Creek	17 March 1980	municipal discharge (Qualicum/ Parksville)	10	82-12	12	
833	Five Finger Island	18 March 1980	municipal discharge	5	81-4	10	
836	Victoria (Macaulay Point)	20 March 1980	municipal discharge	11	no	04	
837	Victoria (Macaulay Point)	20 March 1980	municipal discharge	--	no	04	
838	Victoria (Clover Point)	21 March 1980	municipal discharge	12	no	08	
	French Creek	1981	municipal discharge (Qualicum/ Parksville)	--	82-12		
(track 1)	Point Grey	23 January 1976	ocean dumpsite	49	EPS 5-PR-77-2	30	yes
(track 2)	Point Grey	23 January 1976	ocean dumpsite	49	EPS 5-PR-77-2	30	yes

Continued...

DIVE NO.	LOCATION	DATE	INDUSTRIAL SECTOR INVOLVED	FIGURE NO.	REPORT AVAILABLE	16 mm FILM (approximate length) (minutes)	PHOTOGRAPHS
(track 3)	Point Grey	23 January 1976	ocean dumpsite	49	EPS 5-PR-77-2	30	yes
(track 3A)	Point Grey	24 January 1976	ocean dumpsite	49	EPS 5-PR-77-2	30	yes
(track 4)	Point Grey	24 January 1976	ocean dumpsite	49	EPS 5-PR-77-2	30	yes
(track 5)	Point Grey	24 January 1976	ocean dumpsite	49	EPS 5-PR-77-2	30	yes
380 (tracks 1 & 2)	Thornbrough Channel (Port Mellon)	26 January 1976	ocean dumpsite	50	no	30	
381	Thornbrough Channel (Port Mellon)	26 January 1976	ocean dumpsite	51	no	30	yes
470 (track 1)	Malaspina Strait (off Beaver Island)	30 August 1976	proposed ocean dumpsite (Pender Harbour)	52	no	07	
471 (track 2)	North of Powell River	31 August 1976	ocean dumpsite information	53	no	10	
476 (track 6)	Strait of Georgia (off Nanaimo Harbour)	1 September 1976	ocean dumpsite	54	EPS 5-PR-77-3	06	
477 (track 8)	Strait of Georgia (off Porlier Pass)	2 September 1976	ocean dumpsite	55		11	
478A (track 9) 478B (track 10)	Strait of Georgia (off Porlier Pass)	2 September 1976	ocean dumpsite	55, 56		11	
479 (track 11)	Stuart Channel (Ladysmith Harbour)	3 September 1976	ocean dumpsite pulpmill	57		11	
480 (track 12)	Stuart Channel (Osborn Bay)	3 September 1976	ocean dumpsite pulpmill (Crofton)	58	79-10	11	
592	Saanich Inlet (centre Channel between Mill Bay & Patricia Bay)	8 March 1977	potential ocean dumpsite	59	79-10	06	yes
595	Muchalat Inlet (Gold River)	12 March 1977	pulpmill (Tahsis/Gold River) ocean dumpsite	22		07	
596	Muchalat Inlet (west of Gold River)	12 March 1977	ocean dumpsite pulpmill (Tahsis/Gold River)	22		07	

Continued...

DIVE NO.	LOCATION	DATE	INDUSTRIAL SECTOR INVOLVED	FIGURE NO.	REPORT AVAILABLE	16 mm FILM (approximate length) (minutes)	PHOTOGRAPHS
599 (track 16)	Zeballos Inlet	14 March 1977	ocean dumpsite pulpmill	61		10	yes
600 (track 17)	Zeballos Inlet	14 March 1977	ocean dumpsite pulpmill	62		10	yes
601	Quatsino Sound (east of Koskimo Island)	15 March 1977	ocean dumpsite	63		10	yes
650	off Five Finger Island (Nanaimo ocean dumpsite)	14 April 1978	ocean dumpsite (Nanaimo)	64		02	
714 (track 1)	Point Grey	27 November 1978	ocean dumpsite	49	80-3	30	
715 (track 2)	Point Grey	28 November 1978	ocean dumpsite	49	80-3	30	
716 (track 3)	Point Grey	28 November 1978	ocean dumpsite	49	80-3	30	
717 (track 4)	Point Grey	29 November 1978	ocean dumpsite	49	80-3	30	
718 (track 5)	Point Grey	29 November 1978	ocean dumpsite	49	80-3	30	
759 (track 4)	Victoria (Quarantine Buoy)	9 May 1979	pre 1977 ocean dumpsite	65		11	
758 (track 3)	Victoria (Quarantine Buoy)	9 May 1979	1977 ocean dumpsite	66		11	
	Victoria (off Quarantine Buoy)	8 May 1979	ocean dumpsite	67	no	11	
	Victoria (Quarantine Buoy)	8 May 1979	ocean dumpsite	68	no	11	
	Victoria (off Quarantine Buoy)	9 May 1979	ocean dumpsite	69	no	11	
	Victoria (Constance Bank)	9 May 1979	ocean dumpsite	70	no	08	
826	Malaspina Strait (SE of Grief Point)	10 March 1980	proposed ocean dumpsite	71		03	
828 (track 3)	Johnstone Strait South (west of Kelsey Bay)	12 March 1980	proposed ocean dumpsite	72		06	
829	Kelsey Bay	12 March 1980	proposed ocean dumpsite	73		05	
831 (track 5)	Strait of Georgia (off Porlier Pass)	14 March 1980	ocean dumpsite	74		04	

Appendix II

Representative Photographs
From PISCES IV Dives

PLATE 1 Appearance of typical fibre deposit - Northumberland Channel off Harmac pulpmill

PLATE 2 Wood debris and development of white bacterial slime found under sorting and storage areas - Alberni Inlet in vicinity of Port Alberni pulpmill

PLATE 3 Marine mine trailing deposits forming ridge - Howe Sound near Britannia mine

PLATE 4 Marine mine trailing deposits on flat bottom showing Prickleback fish - Alice Arm

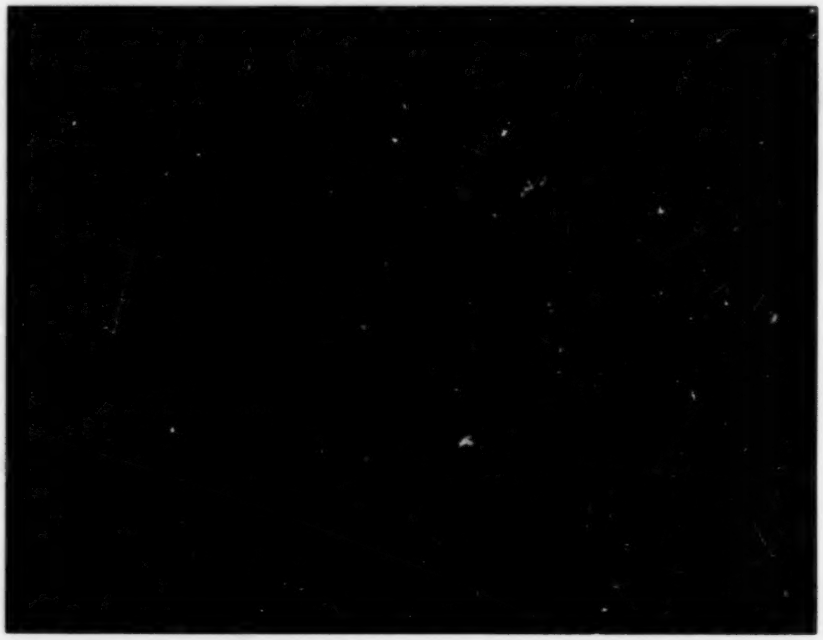

PLATE 5 Leak in pipe at connecting flange of effluent discharge pipe with Quillback Rockfish and Sea Anemone - Five Finger Island off Nanaimo

PLATE 6 Diffuser port of effluent discharge pipe - Five Finger Island

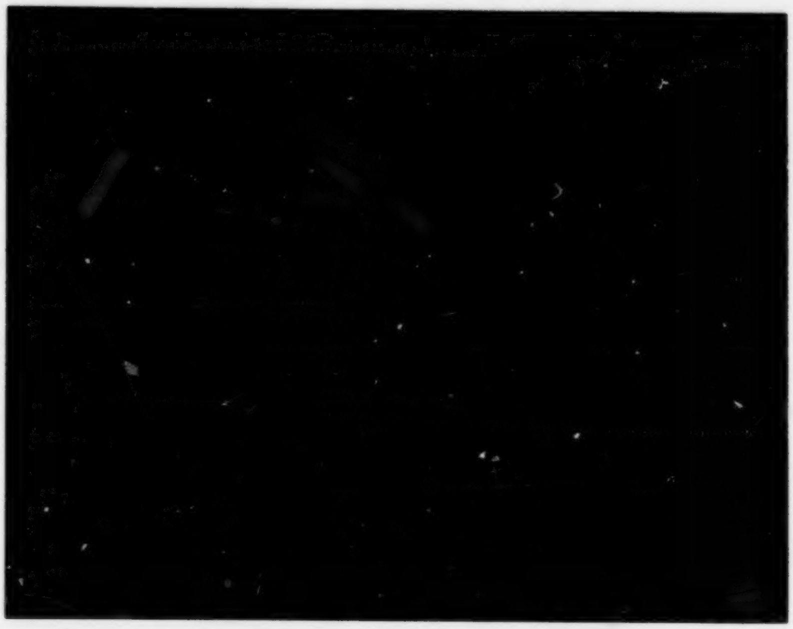

PLATE 7 Dredge spoil consisting of hard pan clay material and concretion with prawns, brittle stars, shrimps, and Neptunea species - Point Grey ocean dumpsite

PLATE 8 Metal banding material - Point Grey ocean dumpsite